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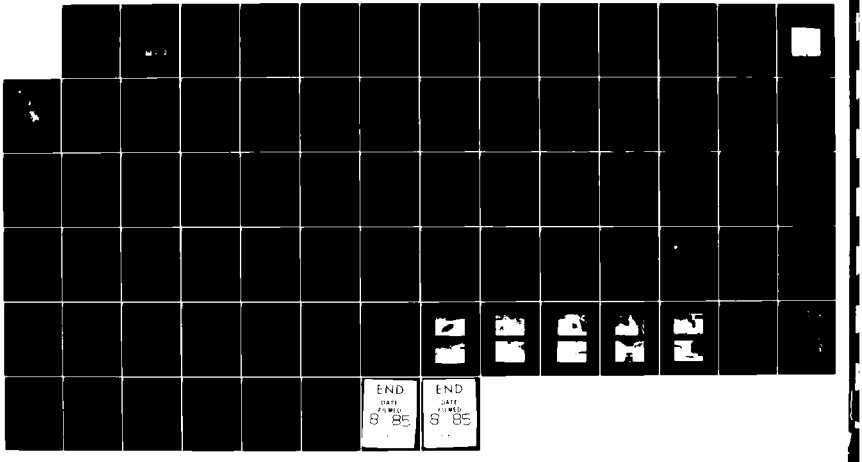

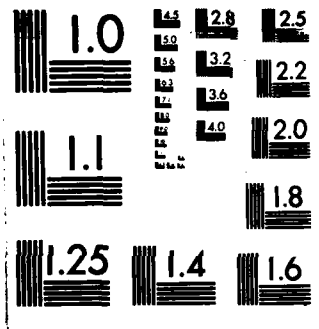

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MERRIMACK RIVER BASIN
LEOMINSTER, MASSACHUSETTS

ROCKWELL POND DAM
MA 00882

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Leominster, Massachusetts
Monoosnoc Brook, tributary of the Merrimack River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a 460 ft. long, 20 ft. high earthfill dam. The dam is in fair condition. This conslusion is based upon the visual inspection at the site, the limited engineering data, and little evidence of operating and maintenance procedures. It is small in size with a hazard potential of high.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

AUG 18 1980

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Rockwell Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, City of Leominster, ATTN: Mr. John Julian, Department of Public Works, 109 Graham Street, Leominster, Massachusetts 01453.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

WILLIAM E. HODGSON, JR.
Colonel, Corps of Engineers
Acting Division Engineer

Incl
As stated

ROCKWELL POND DAM

MA 00882

MERRIMACK RIVER BASIN
LEOMINSTER, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00882

Name of Dam: Rockwell Pond

Town: Leominster

County and State: Worcester County, Massachusetts

Stream: Monoosnoc Brook - Tributary to the Merrimack River

Date of Inspection: November 26, 1979

Rockwell Pond Pond Dam is a 460-foot long, 20-foot high earthfill dam built in the 1800's. An asphalt-paved roadway (Pond Street) is located on the top of the dam. The top of the dam is 55 to 75 feet wide and varies from elevation (El) 421.2 to 422.9. Most of the upstream face of the dam is a vertical concrete retaining wall, while most of the downstream face consists of walls and foundations for structures. The 75.7-foot long, modified sharp-crested spillway has a crest at El 416.4. A concrete bridge spans the spillway channel. The main outlet is a 12-inch diameter. pipe controlled by a valve which is submerged in a manhole. The auxiliary outlet is a 56-inch penstock which terminates with an 8-inch steel pipe and valve inside the Ciprotti Industries Building on the downstream face of the dam.

The dam is in fair condition. There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based upon the visual inspection at the site, the limited engineering data, and little evidence of operating and maintenance procedures.

The following deficiencies were observed at the site: missing riprap and localized growth of brush and small trees on the upstream face of the right

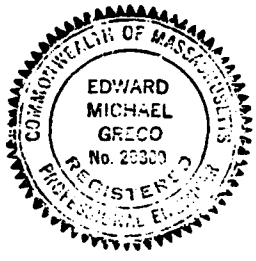
embankment; localized erosion of upstream and downstream earth slopes; voids exposing soil behind the spillway weir wall; cracked or missing mortar from joints in the wpillway training walls; spalled concrete and exposed reinforcing steel on the bridge pier; efflorescence and spalling on the underside of the bridge deck; a submerged inoperable valve on the main outlet; and an inoperable slide gate on the intake of the auxiliary outlet.

Based on Corps of Engineers' guidelines, the dam has been classified as "small" and in the "high" hazard category. The drainage area for the pond is 10.4 square miles. Hydraulic analyses indicate that the spillway at the dam can discharge a flow of 2,600 cubic feet per second (cfs) with the pond at El 421.2, which is the average low elevation on the top of the dam. The test flood (one-half the probable maximum flood (PMF)) produces a peak outflow of 4,310 cfs with the pond at El 422.8. The test flood would overtop the dam by about 1.6 feet. The spillway can discharge 60 percent of the test flood before the dam is overtopped.

Discharge from the Rockwell Pond Dam flows through sections of the downtown area of Leominster. Considerable flooding and damage occurred in that area during the March 1936 and September 1938 floods. Subsequently, the Corps of Engineers prepared a flood control plan for Monoosnoc Brook in reports dated 1976 and 1978 which recommended a tunnel beginning at Rockwell Pond Dam to divert storm flow under downtown Leominster.

It is recommended that the Owner employ the services of a qualified registered engineer to evaluate the stability of the dam and spillway; to design riprap for the upstream face of the dam; to evaluate the condition of the main outlet, valve and manhole; and to evaluate the structural integrity of the bridge over the spillway channel. If the recommended flood control plan by the Corps of Engineers is not funded by Congress in the future, it is further recommended that the Owner employ a qualified registered engineer to conduct detailed hydrologic/hydraulic analyses to evaluate the discharge capacity of the spillway and the overtopping potential of the dam. The Owner should repair the deficiencies listed above, as described in Section 7.3. The Owner should also implement a program of annual technical inspections, a plan for surveillance of the embankment during and after periods of heavy rainfall, and a warning system for downstream factories and residents.

The recommendations and remedial measures outlined above and in Section 7 should be implemented by the Owner within a period of one year after receipt of this Phase I Inspection Report.



Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 29800

Approved by:

Stephen L. Bishop, P.E.
Vice President
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 19703

This Phase I Inspection Report on Rockwell Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

ROCKWELL POND DAM

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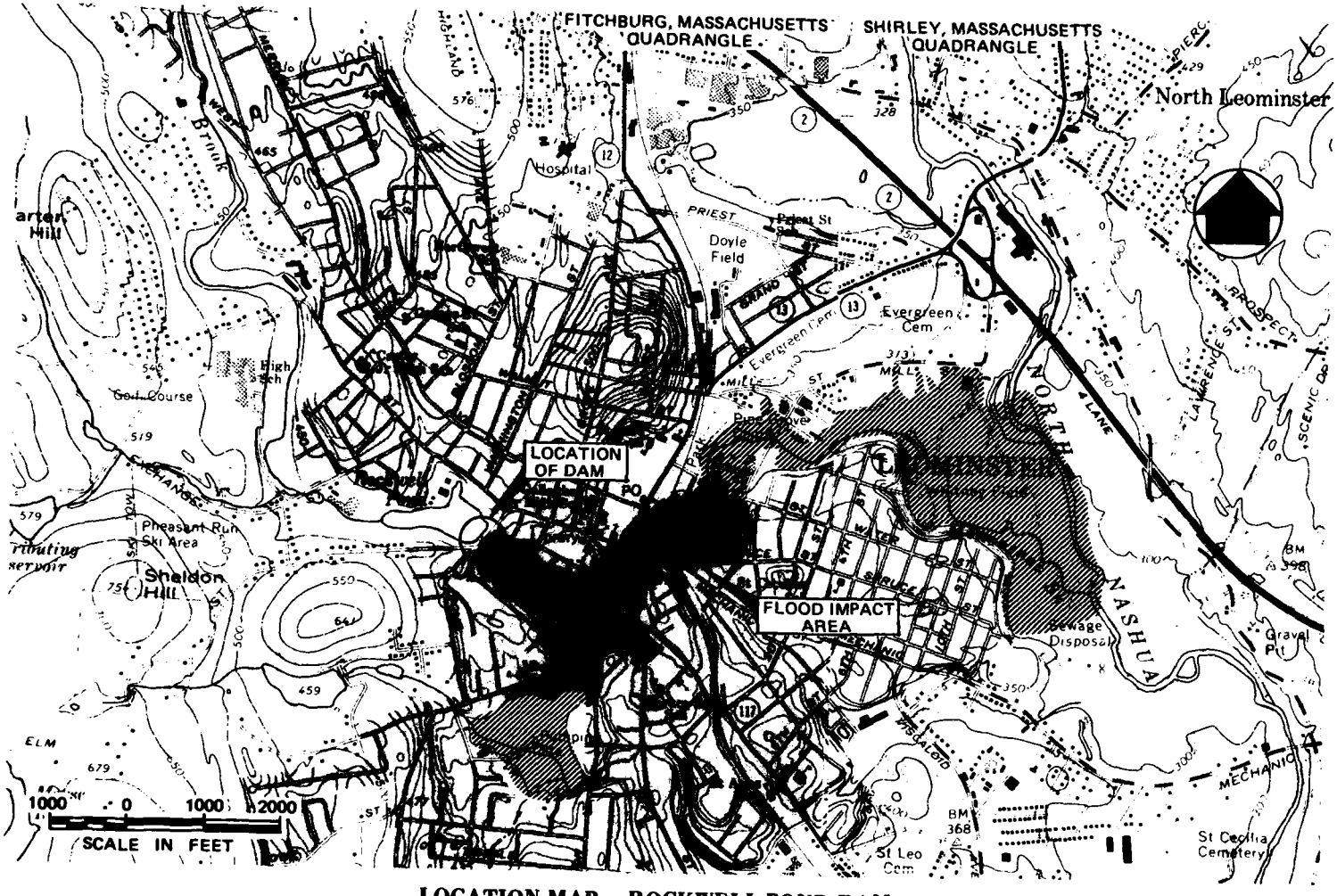
OVERVIEW
ROCKWELL POND DAM
LEOMINSTER, MASSACHUSETTS



LOCATION MAP – ROCKWELL POND DAM

NOTE: LIMITS OF FLOOD IMPACT AREA TAKEN FROM PLATE 9, " HYDROLOGIC ANALYSIS FOR MONOOSNOC BROOK FLOOD CONTROL", NEW ENGLAND DIVISION, CORPS OF ENGINEERS, WALTHAM, MASS., OCTOBER, 1976.

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

ROCKWELL POND DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Divison of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-79-C-0054, dated March 27, 1979, has been assigned by the Corps of Engineers for this work.

b. Purpose:

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam is located on Monoosnoc Brook which drains into North Nashua River, a

tributary of the Merrimack River, in the Town of Leominster, Worcester County, Massachusetts (see Location Map). The coordinates of the dam are latitude 42 deg. 31.6 min. north and longitude 71 deg. 46.0 min. west.

b. Description of Dam and Appurtenances. Rockwell Pond Dam is a 460-foot long earthfill dam (see Plan of Dam and Sections, Figures B-1 and B-2). Due to buildings being located on the downstream face of the dam, it is not possible to measure the height of the dam except at the spillway where the height is 20 feet. Pond Street is an asphalt paved, 30-foot wide roadway constructed on the top of the dam (see Photograph No. 1 in Appendix C). The top is 55 to 75 feet wide and varies from El 421.2 to 422.9. The dam is separated by the spillway into two embankment sections, referred to as the left (north) and the right (south) embankments. A reinforced concrete bridge spans the spillway.

Most of the upstream face of the dam is a 350-foot long, vertical concrete wall (see Photograph No. 2). At the south end of the wall, the upstream face is a 2:1 (horizontal: vertical) earth slope for a length of 60 feet. From the earth slope to the right abutment, the upstream face is a vertical masonry wall 4.5 feet high and 50 feet long. Two clay drains discharge at the base of this masonry wall. At the left abutment of the dam, a 2-foot square box culvert discharges from the upstream face.

Most of the downstream face of the dam is fronted by commercial buildings with adjacent driveways and parking lots. A vertical concrete retaining wall 11 feet high and 45 feet long forms part of the downstream face north of the buildings. There is also a section of earth slope with remnants of a mortared stone wall adjacent to the left abutment (see Photograph No. 4).

The spillway consists of 5 vertical stone masonry walls that form a U-shaped weir in

plan view (see Figure B-4). The walls are capped with concrete that slopes to form a modified sharp-crested weir at El 416.4. The weir is 75.7 feet long and divided in the center by a 3-foot wide concrete pier (see photograph No. 9). The downstream training walls also serve as abutment walls for the bridge. They are vertical stone masonry walls capped with concrete (see Photograph No. 10). The underside of the bridge is 5.7 feet above the crest of the spillway and 14.3 feet above the bottom of the discharge channel. The discharge channel is 40 feet wide. The floor is initially lined with stone masonry for a distance of 20 feet and is then covered with stone and gravel. The sides of the channel are vertical stone masonry walls that also serve as foundation walls for adjacent buildings (see Photograph No. 8). About 200 feet downstream of the dam, the sides of the channel are natural earth slopes.

There are two outlets for the dam. The main outlet is shown on a drawing (see Figure B-4) as being a 12-inch diameter pipe located immediately south of the spillway. The outlet discharges from the right training wall of the spillway (see Photograph No. 6) and has a downstream invert at El 404.5. A manhole beneath Pond Street contains the valve on the main outlet.

The auxiliary outlet is located immediately north of the spillway (see Photograph No. 5). It consists of a slide gate mounted on a concrete intake structure which leads to a 56-inch penstock. The penstock terminates at a bulkhead in the Ciprotti Industries building immediately downstream of the dam. An 8-inch diameter pipe diverts flow from the penstock and discharges from the left wall of the channel below the spillway. The invert of the 8-inch diameter pipe is at El 408.0. A valve located on the 8-inch pipe is what actually controls flow through the auxiliary outlet, since the slide gate is inoperable and partly open.

c. Size Classification. Rockwell Pond Dam is classified in the "small" category since it has a maximum height of 20 feet and a maximum storage capacity of 97 acre-feet.

d. Hazard Classification. Several commercial and industrial buildings are situated immediately downstream of the dam. Thick commercial and residential development continues along the discharge channel for a distance of about 1 mile downstream. In the event of failure of the spillway, it is likely that more than a few lives would be lost and an excessive amount of damage would occur. Accordingly, the dam has been placed in the "high" hazard category.

e. Ownership. According to a conversation with City personnel, the dam is located on property owned by the Salisbury heirs et al and by the City of Leominster, Department of Public Works, 109 Graham Street, Leominster, Massachusetts 01453. Mr. John Julian, Director, Department of Public Works (617-537-8388) granted permission to enter the property and inspect the dam.

f. Operators. The dam is operated by the City of Leominster, Department of Public Works. Personnel from the Ciprotti Industries operate the valve on the auxiliary outlet as instructed by the City of Leominster.

g. Purpose of the Dam. Rockwell Pond Dam serves as a small recreation pond. In earlier years, the pond was used to supply water for power and washing in the Rockwell Woolen Company building located immediately downstream of the dam.

h. Design and Construction History. Drawings dated 1900 show an old dam (see Figure B-3 and B-4) and proposed construction changes. The spillway was reconstructed, and the main outlet was installed. Available drawings from 1935 and 1936 reveal that Pond Street was widened and slightly raised. Apparently, the

old bridge deck was demolished in about 1936 and replaced with a wider reinforced concrete bridge partially supported by a center pier. As a result of heavy spalling of concrete, the footing for the pier was rebuilt about 1975 or 1976. The penstock on the auxiliary outlet formerly lead to a turbine in the Ciprotti Industries Building. Within the last eight years, the turbine was removed, and the canal inside the building was backfilled.

Previous inspection reports indicate that the dam has a history of being in good condition. In the earliest inspection report of 1924 (see Appendix B) the dam is described as good even though a small leak occurred 6 feet below the top of spillway. In 1954, a Leominster City official felt the north abutment of the spillway was in dangerous condition. However, a Civil Defense inspection could not find anything wrong.

A report entitled "Hydrologic Analysis for Monoosnoc Brook Flood Control" dated October 1976 was prepared by the New England Division, Corps of Engineers, Waltham, Massachusetts. An earlier 1965 study had recommended a flood control reservoir on Monoosnoc Brook. However, due to economic considerations and other reasons, this was modified in the 1976 report. Instead, a 12-foot diameter diversion tunnel was proposed that would extend from Rockwell Pond for a distance of 3,200 feet to downstream of Water Street. This was also recommended in subsequent report entitled "Leominster Local Protection, Monoosnoc Brook, Leominster, Massachusetts" dated August 1978 prepared by the New England Division, Corps of Engineers. The recommendations have not yet been implemented and are awaiting Congressional authorization.

1. Normal Operating Procedures. There are no operating procedures at Rockwell Pond. The valve on the main outlet is not used . The slide gate on the auxiliary outlet is slightly open and inoperable. The pond was last

lowered in 1978 by opening the 8-inch valve at the downstream end of the auxiliary outlet. That valve is seldom opened. Personnel from Ciprotti Industries operate the valve as instructed by the City of Leominster.

The spillway is ungated and has no flashboards.

1.3 Pertinent Data

a. Drainage Area. The drainage area for Rockwell Pond is estimated to be 6,656 acres (10.4 square miles) and includes the watersheds of Notown Reservoir and several upstream ponds (see Figure D-1 Drainage Area Map). Most of the drainage area is sparsely developed hilly woodland. Some dense residential development exists between Rockwell Pond and the area north of Pierce Pond.

b. Discharge. Discharge at the dam flows uncontrolled over a 75.7-foot long, modified sharp-crested weir. The crest of the spillway is at El 416.4. Discharge over the spillway drops 12 feet vertically and flows downstream in a 40-foot wide channel with vertical side walls. The main outlet is a 12-inch diameter pipe with a downstream invert at El 404.5. The auxiliary outlet is controlled by an 8-inch diameter pipe with a downstream invert at El 408.0.

Hydraulic analyses indicate that the test flood outflow (one-half the PMF) results in a peak discharge of 4,310 cfs with the pond at El 422.8. The spillway can discharge 2,600 cfs or 60 percent of the test flood outflow before the dam is overtopped. During the test flood, the dam would be overtopped by 1.6 feet and the spillway would be discharging 3,500 cfs.

The only data available on past flood levels at the dam are visual observations recorded in the previous inspection reports and the October 1976 Hydrologic Analysis for Monoosnoc Brook Flood Control by the Corps of Engineers.

The report indicates that the maximum recorded flood occurred on March 18, 1936 and resulted in a calculated pond level at 4 feet above the crest of the spillway.

c. Elevation (feet above National Geodetic Vertical datum of 1929 (NGVD)). A benchmark was established at El 416.4 on the higher edge of the sloped crest of the spillway. This elevation is 1.62 feet lower than El 418.03 (City of Leominster datum) shown on the 1932 drawing entitled Sewer Plan and Profile, Town of Leominster. (The adjustment of -1.62 feet is from the City datum to the National Geodetic Vertical Datum of 1929.) This crest elevation is 0.7 foot higher than crest El 415.7 (mean sea level) listed in US Corps of Engineers reports dated October 1976 and August 1978.

(1) Top of dam: 421.2 to 422.9

(2) Test flood pool: 422.8

(3) Design surcharge: Unknown

(4) Full flood control pool: Not Applicable (N/A)

(5) Recreation pool: 416.4

(6) Spillway crest: 416.4

(7) Upstream portal invert diversion tunnel: N/A

(8) Streambed at centerline of dam: 404.5

(9) Tailwater: 404.5

d. Reservoir

(1) Length of maximum pool: 1,400 feet

(2) Length of recreation pool: 1,400 feet

(3) Length of flood control pool: N/A

e. Storage (acre-feet)

(1) Test flood surcharge: 114 at El 422.8

(2) Top of dam (El 421.2): 97

(3) Flood control pool: N/A

(4) Recreation pool (El 416.4): 44

(5) Spillway crest (El 416.4): 44

f. Reservoir Surface (acres)

*(1) Top of dam: 10.7

*(2) Test flood pool: 10.7

(3) Flood control pool: N/A

(4) Recreation pool: 10.7

(5) Spillway crest: 10.7

g. Dam

(1) Type: earthfill with upstream concrete wall.

(2) Length: 460 feet

(3) Height: 20 feet

(4) Top width: varies from 55 to 75 feet

(5) Side slopes: upstream - vertical concrete wall
downstream - vertical concrete wall and foundation structures

(6) Zoning: Unknown

(7) Impervious core: N/A

*Based on the assumption that the surface area will not significantly increase with changes in pond elevation from 416.4 to 422.8.

(8) Cutoff: Stone masonry core wall 15 feet long perpendicular to each bridge abutment wall

(9) Grout curtain: Unknown

h. Spillway

(1) Type: Stone masonry capped with concrete, modified sharp-crested weir

(2) Length of weir: 75.7 feet total

(3) Crest elevation: 416.4

(4) Gates: None

(5) Upstream channel: No training walls; bottom not visible.

(6) Downstream channel: Flat-bottomed bed lined with masonry for a distance of 20 feet and then covered with loose stone and gravel. Stone masonry training walls under bridge and extending about 200 feet downstream of bridge.

i. Regulating Outlets. There are two regulating outlets at this dam. The main outlet is a 12-inch diameter pipe that discharges through the right training wall of the spillway. The pipe is about 35 feet long and flow is controlled by a valve located in a brick manhole beneath Pond Street. Although this valve was slightly opened about four years ago, it has been 40 years since the valve was fully opened. For that reason, it is considered inoperable.

The auxiliary outlet is an 8-inch diameter pipe leading from a penstock located in the Ciprotti Industries building on the left side of the spillway channel. Flow is controlled by a valve on the 8-inch line. Flow into the penstock is controlled by a slide gate on the intake structure. The slide gate is partially open.

SECTION 2

ENGINEERING DATA

2.1 General. There are two sheets of drawings of the dam dated June 26, 1900, four sheets of drawings of the bridge dated August 1936 and reports and notes from past inspections available from the Worcester County Engineer's Office and the Massachusetts Division of Waterways. There are also several drawings dated 1935 and 1936 describing the widening of Pond Street available from the City of Leominster, Department of Public Works and William R. Bingham & Associates, Engineers. No other plans, specifications or computations are available from the Owner, State or County relative to the design or construction of the dam. Visual observations during inspection, review of previous inspection reports, and conversations with the Owner and personnel from Ciprotti Industries and Rockwell Roofing & Siding Co. provided the remainder of the data for this evaluation.

We acknowledge the assistance and cooperation of personnel from the City of Leominster, the Worcester County Engineer's Office, the Massachusetts Division of Waterways, Ciprotti Industries and Rockwell Roofing and Siding Company.

2.2 Construction Records. There are no construction records or as-built drawings for this dam, only the proposed construction drawings.

2.3 Operating Records. No operating records are available, and no daily record is kept of the pool elevation or amount of rainfall at the dam. A USGS gaging station is located about 5 miles downstream from the dam on the North Nashua River.

2.4 Evaluation

a. Availability. Due to the age of this dam, there is limited engineering data available.

b. Adequacy. The lack of detailed hydraulic, structural and construction data did not allow

for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on the visual inspection, past performance history and engineering judgment.

c. Validity. Comparison of the available drawings with the field survey conducted during the Phase I Inspection indicates that the available information is valid. An exception to this was the downstream end of the main outlet pipe which was measured as 20-inch diameter. Personnel from the City of Leominster reported that this is only a sleeve and that the pipe upstream of the sleeve is 12-inch diameter, as shown on the drawings (see Figure B-4).

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The Phase I Inspection of the dam at Rockwell Pond was performed on November 26, 1979. A copy of the inspection checklist is included in Appendix A. Inspection reports since 1924 were reviewed at the Worcester County Engineer's Office.

b. Dam. In general the dam is in fair condition. The top of the dam is paved with asphalt which is in good condition. Drainage from the road is collected in catchbasins which discharge into the pond through a box culvert located on the upstream face of the dam (see Figure B-1).

The concrete wall on the upstream face of the dam is in fair condition. North of the spillway, there are several vertical hairline cracks located between the expansion joints. The concrete face was stained and slightly pitted. A fence consisting of concrete posts and pipe railings is located on the upstream edge of the top of the dam. Beyond the south end of the concrete wall, the upstream face of the dam is a steep earth slope covered with brush, grass and scattered large pieces of riprap (see photograph 3 in Appendix C). Between this area and the right abutment is a vertical stone wall, partially mortared, with an outward bulge. Water was slowly discharging from one of the two clay tile drain lines located at the bottom of the stone wall. Severe erosion of the soil has occurred at the south end of the wall. A wooden fence along the upstream edge of the southern end of the dam has broken and is missing rails.

Most of the downstream face of the dam is covered by commercial buildings. Occupants of these buildings report no water seepage into the bottom level which is considerably below the reservoir surface. A vertical concrete

retaining wall forms the downstream face of the dam north of the Ciprotti Industries Building. Erosion has occurred at the footpath behind the retaining wall and at the north end of the wall. The downstream slope of the dam between the retaining wall and the left abutment is covered with grass and brush and remnants of a vertical mortared stone wall (see photograph 4 in Appendix C).

c. Appurtenant Structures. The dry stone masonry spillway, capped with concrete, has a modified sharp crested weir (see photograph 7 in Appendix C). The spillway is in poor to fair condition. At the time of inspection, water was flowing over the spillway. Logs and other debris were caught on the weir. At the northwest corner of the spillway wall, sandy soil was observed in and behind the open joints between individual stones. Open joints up to 18 inches deep were measured from the front of the wall to the soil behind the wall.

The spillway walls merge into stone masonry training walls which also serve as abutment walls for the bridge (see photographs 9 and 10 in Appendix C). The stonework of the training walls is in fair condition. Some of the mortar is cracked or missing. The top of each abutment wall is covered with a concrete cap wall which is stained and slightly pitted. There is minor spalling of the concrete bridge pier and footing. Severe spalling has occurred locally on the sides of the pier, exposing the reinforcing steel which has corroded. The corners of the footing that supports the pier are also spalled.

The reinforced concrete bridge which spans the spillway is in fair condition. There are no cracks visible on the asphalt paved deck. The concrete on the walls and the underside of the deck is spalled and stained. Efflorescence of the concrete ranges from minor on the exposed beams to heavy at the weep holes exposed on the underside of the deck.

The main outlet, which is reported to be a 12-inch diameter pipe, is in poor condition. The inlet is not visible. The valve is submerged in the manhole chamber. The discharge end of the outlet pipe contained some debris. A trickle of water was observed, although the valve was reportedly closed (see photograph 6 in Appendix C).

The concrete intake structure for the auxiliary outlet is in fair condition (see photograph 5 in Appendix C). There is some spalling of the concrete. A trash rack is located on on the west side of the structure. The bars are slightly corroded and bent. The timbers forming the deck of the structure have deteriorated. Debris has accumulated inside the structure. The rack and pinion gear mechanism for the slide gate is in poor condition with missing or broken parts. the gate is reported to be partly open. The valve on the 8-inch diameter line was reportedly last operated in 1978.

d. Reservoir Area. There is moderate residential development, including apartment houses and some commercial units, along the shoreline except on the west edge of the pond. The topography is flat to the north and east and very hilly to the south and west. Monoosnoc Brook flows into the west end of the pond.

e. Downstream Channel. The mortared stone walls that form the sides of the discharge channel are in fair condition (see photograph 8 in Appendix C). Some of the mortar in these walls, which also serve as the foundation for abutting buildings, is missing or has cracked.

The discharge channel contains scattered debris at the bottom of the spillway. Under the bridge, some pieces of the lining stone are dislodged. The bottom of the channel adjacent to both training walls is covered with a random thickness of concrete which is being undermined. Downstream of the bridge, the channel is relatively clear of debris except for a few small logs. A portion of one building overhangs the

left side of the discharge channel (see Photograph No. 8). Both sides of the channel contain a few large rocks and growth of small trees and vines.

3.2. Evaluation. The above findings indicate that the dam is in fair condition. There are several deficiencies which require attention. Recommended measures to improve these conditions are stated in Section 7.3.

SECTION 4

OPERATING PROCEDURES

4.1 Procedures. Under normal conditions, the valves on both outlet pipes are closed. The valve for the main outlet is submerged inside a manhole. The last time this valve was fully opened was about 40 years ago. About four years ago, the valve was slightly opened by City personnel. A small amount of water discharged, and the valve was immediately closed. This valve is considered inoperable.

The slide gate for the auxiliary outlet is reportedly partially open and is not operated. The valve on the 8-inch pipe located in the Ciprotti Industries Building was last operated in 1978. It is usually operated by personnel from Ciprotti Industries as directed by the City of Leominster.

Flashboards are not used on the spillway.

4.2 Maintenance of Dam. There is no regular maintenance program for the dam. However, because the dam abuts private property and is used as a roadway, it is periodically maintained. For example, the City replaced a badly deteriorated sidewalk and repaired the heavily spalled bridge pier footing.

4.3 Maintenance of Operating Facilities. There is no regular maintenance program for the operating facilities.

4.4 Description of Any Warning System in Effect. There is no warning system in effect at the dam.

4.5 Evaluation. There are no regular programs of maintenance or technical inspections at the dam. There are also no plans for surveillance of the dam during periods of heavy rainfall or for warning people in downstream areas in case of an emergency at the dam. This is extremely

undesirable, considering that the dam is in the "high" hazard category. These programs should be implemented as recommended in Section 7.3.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General. Rockwell Pond Dam is located at the western edge of dense commercial development in downtown Leominster. The drainage area is 10.4 square miles (6,656 acres). The topography of the watershed is hilly and mostly wooded. The upper 4.7 square miles of the watershed drains into Notown Reservoir which is a domestic water supply. An unnamed tributary and Monoosnoc Brook drain into Rockwell Pond. There are several control structures in the lower watershed upstream of Rockwell Pond

Rockwell Pond has a surface area of 10.7 acres and a maximum storage capacity of 97 acre-feet. The dam is a 460-foot long earthfill embankment. The spillway is 75.7 feet long with the crest at El 416.4. Discharge flows uncontrolled over the spillway and continues downstream in a narrow, vertically-walled channel that winds between factory buildings and beneath roadways. The main outlet is a 12-inch pipe with an invert at El 404.5. The outlet discharges into the channel below the spillway. The outlet can discharge a flow of 16 cfs with the pond at El 415.8. With the pond at El 415.8 and assuming no inflow, the outlet can lower the pond by 1 foot in about eight hours.

A hydrologic analysis of Monoosnoc Brook in Leominster was performed by the Corps of Engineers. Their report, dated October 1976, discussed a proposed flood control diversion tunnel that would begin at Rockwell Pond Dam and discharge 3,200 feet downstream. Using a "standard project flood", a peak discharge of 4,000 cfs was calculated for Rockwell Pond Dam. The tunnel would be 12 feet in diameter and divert 3,400 cfs, while the remaining 600 cfs would flow into the channel below the dam.

The hydraulic analysis is also a part of the feasibility report dated August 1978 for water resources development also written by the Corps of Engineers.

b. Design Data. There are no hydraulic or hydrologic computations available for the design of the dam or appurtenances.

c. Experience Data. There are no records of overtopping of the dam. A U.S. Geological Survey gaging station is located about 5 miles downstream on the North Nashua River. The drainage area for the gaging station is 107 square miles. Discharge records dating back to 1935 indicate that a maximum discharge of 16,300 cfs occurred on March 18, 1936. In their hydraulic analyses, the Corps of Engineers calculated that this flood produced a peak discharge of 1,885 cfs at Rockwell Pond Dam with the pond 4 feet above the crest of the spillway. This water level corresponds to El 420.4 which is 0.8 foot below the low point on the crest of the dam.

d. Visual Inspection. A bridge deck that supports Pond Street spans the crest of the spillway. The opening above the spillway is about 6 feet high and is not likely to clog with debris. However, logs were caught on the crest at the time of inspection and some additional debris had accumulated downstream of the spillway. A corner of one of the factory buildings overhangs the downstream channel below the dam (see photograph 8 in Appendix C.)

The valve controlling flow through the main outlet conduit is located in a manhole beneath Pond Street. The valve is submerged and the water level is about 10 feet below the street level. The valve has not been fully opened for 40 years and is considered inoperable. An auxiliary outlet includes an 8-inch diameter pipe and valve which discharges water from the penstock terminating in the Ciprotti Industries Building.

e. Test Flood Analysis. According to the Corps of Engineers' guidelines, the dam has been

placed in the "small" size and "high" hazard categories. A test flood ranging from a one-half to a full probable maximum flood (PMF) should be used to evaluate the capacity of the spillway. The one-half PMF is used in the following analysis.

The test flood inflow was determined by adjusting the standard project flood flow used in the Corps of Engineers' hydraulic analysis. The standard project flood is based on an 8.7 inch rainfall, and the one-half PMF is based on a 9.5-inch rainfall. By increasing the standard project flood flow of 4,000 cfs proportionately, the test flood inflow is calculated to be 4,370 cfs. After adjusting for surcharge storage, the test flood outflow is 4,310 cfs (414 cfs per square mile) with the pond at El 422.8.

The spillway can discharge 2,600 cfs or 60 percent of the test flood outflow when the pond is at El 421.2, the low point on the top of the dam. During the test flood, the dam would be overtopped by a maximum of 1.6 feet. Most of the remainder of the dam would be overtopped by less than 0.6 foot of water during the test flood. About 1,270 cfs would discharge over the top of the dam. At critical flow conditions, the water would be 0.94 foot deep and have a velocity of 5.5 feet per second.

f. Dam Failure Analysis. The peak discharge rate due to failure of the dam was calculated to be 4,100 cfs. This is based on a maximum head of 17.3 feet and an assumed 23-foot wide breach occurring south of the pier in the spillway section. The peak discharge rate includes 2,800 cfs through the breached half of the spillway (south of the pier) and 1,300 cfs flowing over the intact half of the spillway (north of the pier). Failure of the dam would produce a downstream flood wave 8 feet deep as compared to a 6-foot deep channel flow prior to failure. It would take about 50 minutes to drain the pond.

There are numerous factory buildings adjacent to the channel downstream of the dam. The sills of these buildings are 6 to 7 feet above the bottom of the channel. A corner of one building has been built out into the channel about 60 feet below the dam. The failure flow could result in overflowing of the channel sides in some areas farther downstream. Due to the configuration of the channel, little attenuation of the flood flow is expected. It is likely that failure of the dam would result in excessive property damage and possible loss of more than a few lives in highly urbanized areas downstream. Accordingly, the dam has been placed in the "high" hazard category.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The evaluation of the structural stability of Rockwell Pond Dam is based on review of available drawings and previous inspection reports and the visual inspection conducted on November 26, 1979. As discussed in Section 3, Visual Inspection, the dam is in fair condition.

It is recommended that a more detailed investigation be initiated to evaluate the stability of the dam and spillway. This is based on visual observations of the condition of the structures, and on the presence of sandy soil in and behind open joints between stones on the downstream face of the spillway.

b. Design and Construction Data. The dam was originally built sometime prior to 1900. The information listed in Section 2, Engineering Data, represents the available drawings dated 1900, 1935 and 1936. One plan (Figure B-3) shows that there are cutoff walls extending 15 feet into the dam from both spillway training walls. There are no other plans, specifications or computations available on the design and construction of this dam from the Owner, County or State offices.

Information does not appear to exist on the type, shear strength or permeability of the soil and/or rock materials of the embankment.

c. Operating Records. There is no evidence of instrumentation of any type in Rockwell Pond Dam, and there is nothing to indicate that any instrumentation was ever installed in this dam. The performance of the spillway and dam under prior loading can only be inferred from physical evidence at the site.

d. Post-construction Changes. There are no as-built drawings available for Rockwell Pond. The drawings dated 1900 show an outline of the original dam and proposed changes constructed prior to 1924. In about 1936, the bridge spanning the spillway was replaced with a wider reinforced concrete bridge partially supported by a center pier. About four years ago, the footing for the pier was repaired. Within the last eight years, the penstock on the auxiliary outlet was plugged at the downstream end. An 8-inch pipe and valve were installed to divert water to the spillway discharge channel.

e. Seismic Stability. The dam is located in Seismic Zone No. 2, and in accordance with Phase I "Recommended Guidelines" does not warrant seismic analysis at this time.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Generally, the dam is considered to be in fair condition. Based upon a review of available drawings, the visual inspection of the site, and limited information on operation and maintenance, the following deficiencies must be corrected to assure the continued performance of this dam: Missing riprap and localized growth of brush and small trees on the upstream slope of the right embankment; localized erosion of both slopes; voids between some of the stones exposing soil behind the spillway weir wall; cracked or missing mortar from joints in the spillway training walls; spalled concrete and exposed reinforcing steel on the bridge pier efflorescence and spalling on the underside of the bridge deck; a submerged and inoperable valve on the main outlet; and an inoperable slide gate on the intake of the auxiliary outlet.

Hydraulic analyses indicate that the spillway can discharge 2,600 cfs or 60 percent of the test flood outflow with the pond at El 421.2, which is the average low elevation on the top of the dam. The test flood outflow (one-half the PMF) is estimated to be 4,310 cfs and will overtop the dam by a maximum of 1.6 feet. Discharge from Rockwell Pond Dam flows through sections of downtown Leominster which was damaged during the March 1936 and September 1938 floods. Subsequently, the Corps of Engineers prepared a flood control plan for Monoosnoc Brook which recommended a tunnel beginning at the Rockwell Pond Dam to divert storm flow under downtown Leominster.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing

design and construction data, but is based primarily on a review of available drawings, the visual inspection, past performance history and engineering judgment.

c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.

d. Need for Additional Investigation. Additional investigations to further assess the adequacy of the dam are outlined below in Section 7.2, Recommendations.

7.2 Recommendations. It is recommended that the Owner employ a qualified registered engineer to:

a. Evaluate the stability of the dam and spillway. This should include an inspection of the spillway under a no flow condition and an evaluation of the extent of voids behind the spillway weir.

b. Inspect and evaluate the main outlet, submerged valve and valve chamber. A suitable means of access to operate the valve should be designed.

c. Design riprap for the upstream face of the dam.

d. Evaluate the structural integrity of the bridge.

As has been mentioned in Section 1.2h, the Corps of Engineers has recommended the construction of a 12-foot diameter diversion tunnel which will divert flood flows from Rockwell Pond, carry them under central Leominster and discharge them back into Monoosnoc Brook downstream from Water Street. The proposed work would also include modifications to the existing 75.7 foot spillway. Construction of the improvements would obviate the need for any further hydraulic study of the spillway of Rockwell Pond Dam. A feasiblity report on this Leomonster Local

Protection Project has been forwarded by the Corps to Washington for approval and subsequent funding. If this work is not funded by Congress in the future, it is further recommended that the Owner's consultant should:

e. Perform a detailed hydrologic/hydraulic analysis to determine the adequacy of the spillway discharge capacity and the overtopping potential of the dam.

The Owner should implement the recommendations of the registered engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:

(1) Selectively clear trees, brush and roots from the dam embankments. All stumps and roots removed should be backfilled with select material.

(2) Fill in eroded areas on the upstream and downstream face of the earth embankment portions of the dam.

(3) Replace missing or cracked mortar in the spillway training walls. This should not include the spillway weir walls, unless recommended by the engineer, as discussed in Section 7.2.a.

(4) Repair the slide gate and rack and pinion gear mechanism on the auxiliary outlet to a working condition.

(5) Replace the deck timbers at the intake structure on the auxiliary outlet.

(6) Repair all spalled and deteriorated concrete on the bridge pier. This should conform to recommendations made by the engineer as discussed in Section 7.2.d.

(7) Remove all brush, trees, debris and loose stone in the floor of the spillway discharge channel.

(8) Remove logs and debris caught on the spillway weir and inside the auxiliary outlet structure.

(9) Remove debris from the downstream end of the main outlet pipe.

(10) Institute a definite plan for surveillance of the dam and spillway during periods of heavy rainfall and a plan to warn people in downstream areas in the event of an emergency at the dam.

(11) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances and be supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in compliance with all applicable State regulations. The maintenance program should include removal of any debris caught on the spillway weir to prevent clogging of the spillway.

(12) Technical inspections of this dam should be conducted on an annual basis.

7.4 Alternatives. There are no recommended alternatives.

APPENDIX A

PERIODIC INSPECTION CHECKLIST

ROCKWELL POND DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT ROCKWELL POND

DATE November 26, 1979

TIME 8:00 AM-3:30 PM

WEATHER Cloudy, rain 50° F.

W.S. ELEV. 416.4 U.S. ____ DN.S.

PARTY:

1. Michael Larson
2. Scott Nagel
3. William Checchi
4. Frank Sviokla
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam	Michael Larson	
2.	Spillway	Lyle Branagan	
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT ROCKWELL POND DATE November 26, 1979

PROJECT FEATURE Dam Embankment NAME M. Larson

DISCIPLINE Geotechnical NAME

Note: U/S = upstream; D/S = downstream

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	Varies from 422.9 to 420.7
Current Pool Elevation	416.4
Maximum Impoundment to Date	
Surface Cracks	None
Pavement Condition	~~Good.~~ Crest is 2 lane asphalt pavement for Pond Street. Contains several manhole covers.
Movement or Settlement of Crest	None visible except localized movement of anchor block for exposed sewer on southeast bridge corner.
Lateral Movement	None visible
Vertical Alignment	~~Slight rise from both abutments to~~ concrete bridge at center of dam.
Horizontal Alignment	Left side straight except skewed close to left abutment. Right side is curved roadway.
Condition at Abutment and at Concrete Structures	~~Lt. abutment-good-natural ground, paved road-~~ way, U/S is asphalt parking lot placed on some fill. Rt. abutment-good-paved asphalt with intersection of 3 streets.
Indications of Movement of Structural Items on Slopes	U/S slope is mostly a vertical conc. wall wi no apparent movement; a vertical stone wall near rt. abutment has a bulge into reservoir D/S slope is covered with buildings except near lt. abutment; fill under transformer pad in this area has settled and north conc. blo wall has settled.
Trespassing on Slopes	~~Crest is Pond St. with sidewalk on both side~~ Paved driveway along left D/S slope.
Sloughing or Erosion of Slopes or Abutments	Eroded footpath next to transformer station Some erosion on U/S right embankment.
Rock Slope Protection - Riprap Failures	Isolated large granite blocks on right U/S slope appears sloughed. Few isolated stone on U/S left abutment.
Unusual Movement or Cracking at or near Toes	None visible; visibility extremely limited due to presence of buildings on D/S slope.
Unusual Embankment or Downstream Seepage	None visible.
Piping or Boils	None visible.
Foundation Drainage Features	None visible.
Toe Drains	None visible.
Instrumentation System	None

1. and catchbasins. Ponded water at low spot between U/S edge of road & asphalt covered sidewalk.

PERIODIC INSPECTION CHECK LIST

PROJECT ROCKWELL POND DATE November 26, 1979

PROJECT FEATURE Outlet Works Bridge NAME M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - POND STREET BRIDGE	
a. Super Structure	Concrete. Fair condition, built in two lengths, with longer beams on U/S side.
Bearings	None visible
Anchor Bolts	None visible
Bridge Seat	Not visible
Longitudinal Members	Concrete beams. Minor spalling & efflorescence on underside of beams.
Under Side of Deck	Concrete monolithic with longitudinal beams.
Secondary Bracing	One lateral conc. beam brace D/S of center pier between longitudinal beams.
Deck	Covered with asphalt pavement.
Drainage System	3-inch tile drains are exposed on underside of deck. Drains are plugged, but considerable efflorescence on immediate concrete
Railings	Solid conc. wall on each side of bridge.
Expansion Joints	None visible.
Paint	
b. Abutment and Piers	Consists of one center conc. pier & stone masonry abutments each with a concrete cap wall.
General Condition of Concrete	Fair. Reinforcing steel exposed on face of center pier.
Alignment of Abutment	Slightly skewed from being perpendicular to alignment of Pond Street.
Approach to Bridge	Asphalt pavement roadway beyond both abutments.
Condition of Seat and Backwall	Concrete cap walls in fair condition. Missing mortar in masonry abutment walls throughout, and especially at base of rt. abutment wall. 20-inch cast iron pipe egresses at base of right wall.

PERIODIC INSPECTION CHECK LIST

PROJECT ROCKWELL POND DATE November 26, 1979

PROJECT FEATURE Main Outlet Works .E M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL General Condition of Concrete	Brick lined chamber, manhole partially submerged with water level about 10 feet below road surface. Valve completely submerged.
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel	Exit pipe is 20 inch diameter cast iron pipe, partially filled with debris.
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

PERIODIC INSPECTION CHECK LIST

PROJECT ROCKWELL POND DATE November 26, 1979

PROJECT FEATURE Auxiliary Outlet Works NAME M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
AUXILIARY OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Not visible, submerged
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	Refer to outlet works-control tower
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT ROCKWELL POND DATE November 26, 1979

PROJECT FEATURE Auxiliary Outlet Works NAME M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
AUXILIARY OUTLET WORKS - CONTROL TOWER	Concrete substructure covered with timber deck.Steel plate nailed to timber floor serves as access hatch on north side.Metal trash bars on west side intake.
a. Concrete and Structural	
General Condition	Concrete-fair.Timber floor-rotting and poor.Steel plate cover-fair & rusting.
Condition of Joints	N/A
Spalling	Exterior conc.is lightly to moderately spalled.
Visible Reinforcing	None visible.
Rusting or Staining of Concrete	Yes, mostly on north exterior wall.
Any Seepage or Efflorescence	Very slight
Joint Alignment	N/A
Unusual Seepage or Leaks in Gate	Submerged - not visible.
Cracks	None visible.
Rusting or Corrosion of Steel	Some rust of steel cover plate
b. Mechanical and Electrical	Rack and pinion gear mechanism exposed on timber floor, on south wall. Apparent slide gate below was submerged. Appears non operable, parts missing.
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

PERIODIC INSPECTION CHECK LIST

PROJECT ROCKWELL POND DATE November 26, 1979

PROJECT FEATURE Auxiliary Outlet Works NAME M. Larson

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
AUXILIARY OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	An 8-inch pipeline with valve was tapped into terminal end of plugged canal inside Ciprotti Industries Building.
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	None visible.
Condition at Joints	
Drain Holes	
Channel	8-inch pipeline empties into spillway channel.
Loose Rock or Trees Overhanging Channel	Few small trees along edge of spillway channel.
Condition of Discharge Channel	Fair

PERIODIC INSPECTION CHECK LIST

PROJECT ROCKWELL POND DATE November 26, 1979

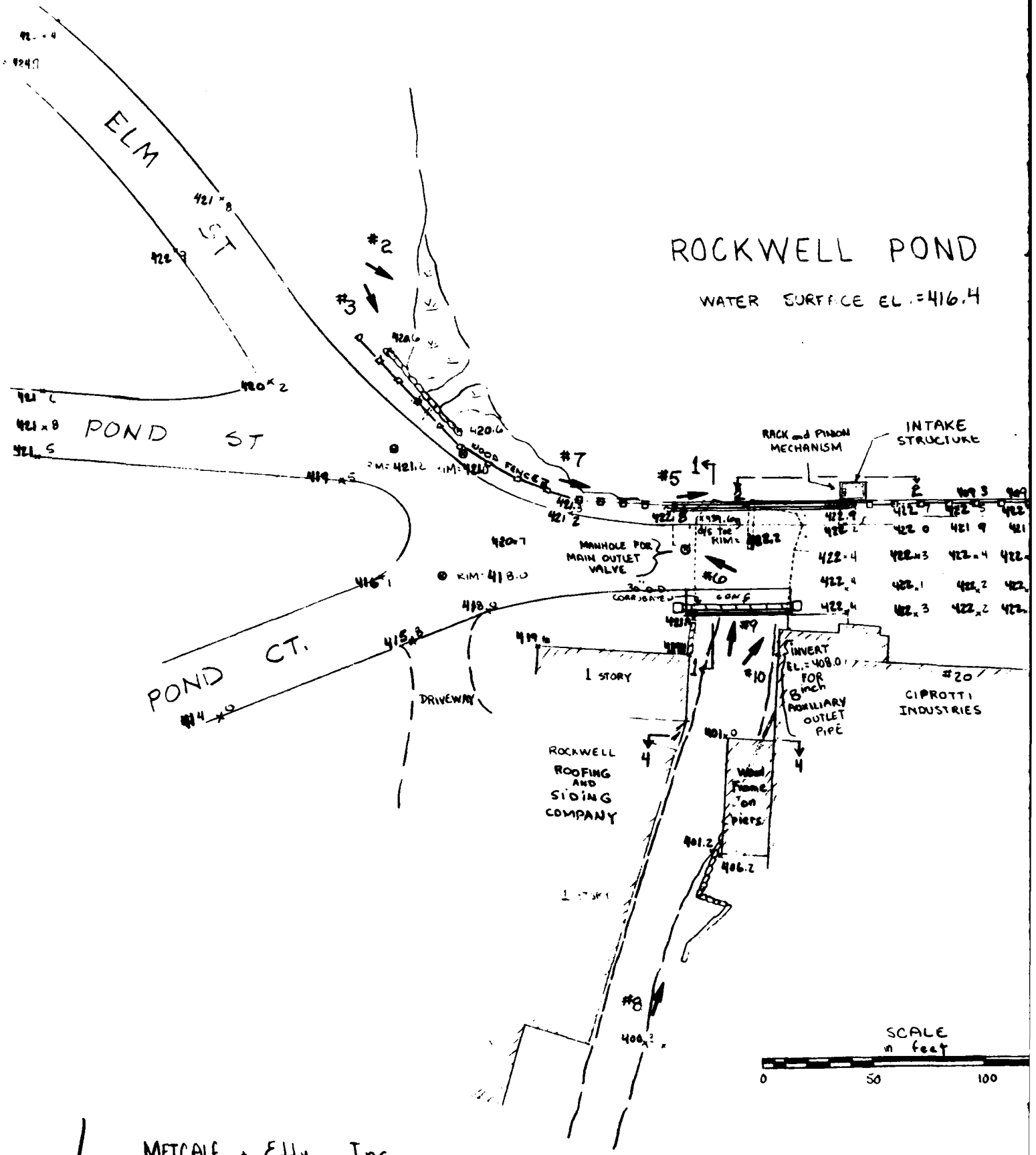
PROJECT FEATURE Spillway NAME M. Larson

DISCIPLINE Hydraulic NAME L. Branagan

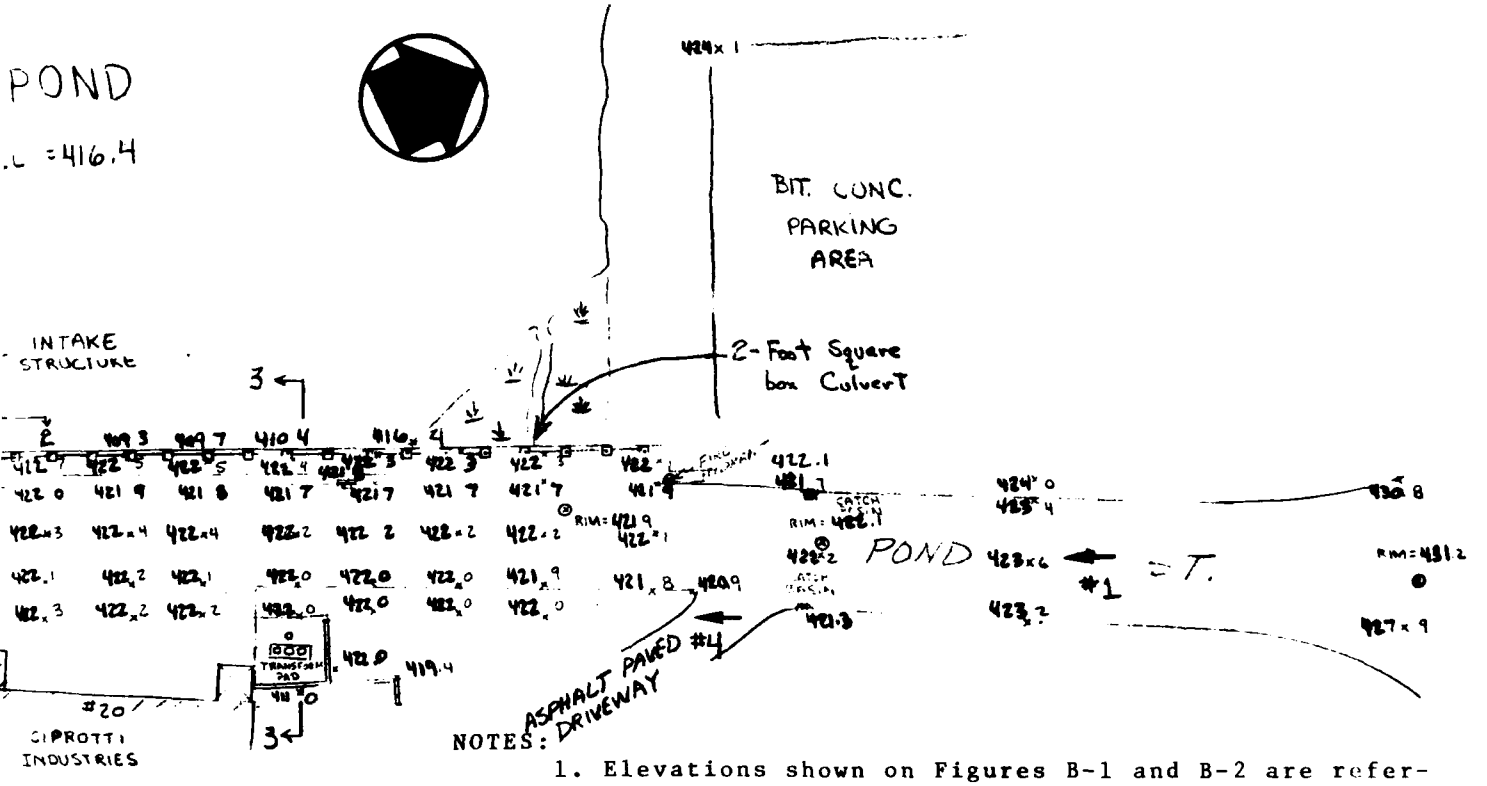
AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Submerged
General Condition	Not visible
Loose Rock Overhanging Channel	N/A
Trees Overhanging Channel	None
Floor of Approach Channel	Not visible.
b. Weir and Training Walls	Most of weir is dry stone with conc.cap. Training walls described under abutments for Pond Street Bridge.
General Condition of Concrete	Concrete cap appears fair, but limited visibility. Open joints in left weir corner & lt.weir wall reveal sandy soil behind stone wall, could probe12" to 18" into open joints from face of wall.
Rust or Staining	Rust on right wall of right weir.
Spalling	N/A
Any Visible Reinforcing	N/A
Any Seepage or Efflorescence	Not visible
Drain Holes	None
c. Discharge Channel	Vertical mortared masonry walls for about 150' D/S of spillway. Natural streambed beyond.
General Condition	Fair
Loose Rock Overhanging Channel	Few small stones along bank D/S of building on left bank.
Trees Overhanging Channel	Few small trees immediately D/S of bridge numerous trees further D/S in natural streambed.
Floor of Channel	Under bridge, floor is stone lined. Stones are tied together with pins. Beyond bridge channel floor is natural with many small stones.
Other Obstructions	Wooden structure mounted on conc.pillars on left bank overhangs stream channel. Some debris just D/S of weir, other debr and small trees further D/S in channel.

APPENDIX B

PLANS OF DAM AND PREVIOUS
INSPECTION REPORT



METCALF + Eddy, Inc.



NOTES:

1. Elevations shown on Figures B-1 and B-2 are referenced to the spillway crest (City of Leominster datum) of El 418.03, as shown on 1932 Sewer Plan and Profile, City of Leominster. An adjustment of minus (-) 1.62 feet yields the National Geodetic Vertical Datum of 1929 (NGVD) and subsequent crest elevation of 416.4. This is 0.7 foot higher than crest El 415.7 MSL listed in U.S. Corps of Engineer reports dated October, 1976 and August, 1978.
2. Information shown based on field survey of November 26.1979.
3. See Figure B-2 for sections through Dam.
4. #2 indicates location and direction of view for photographs.

SCALE
in feet
100 150

METCALF & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

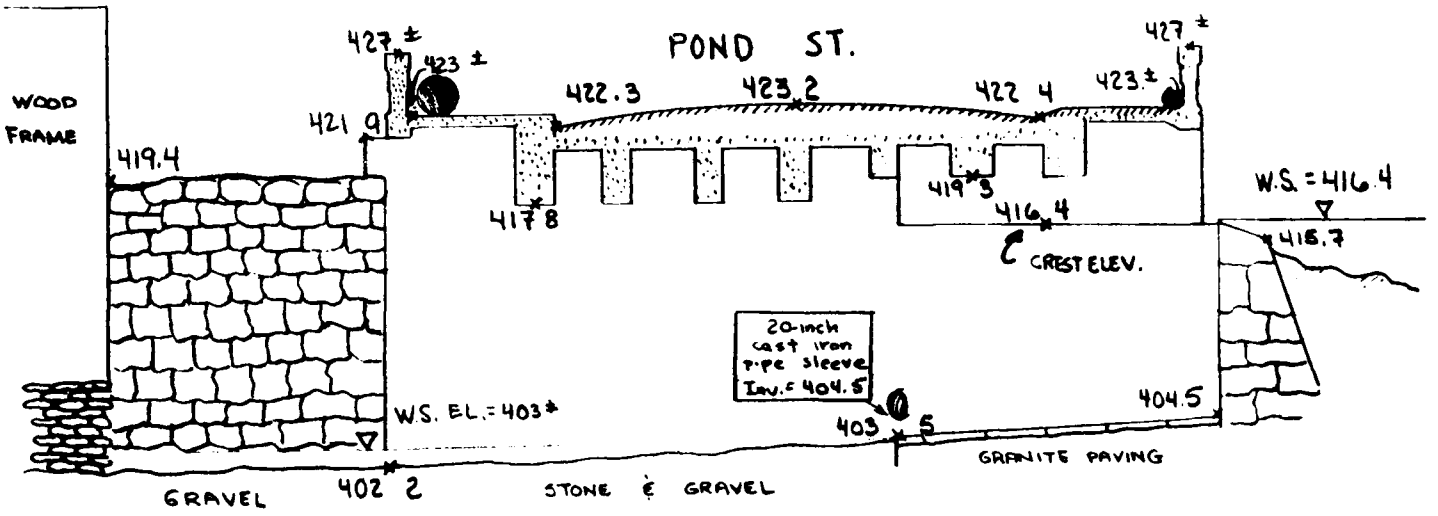
ROCKWELL POND DAM

FIGURE B-1 PLAN OF DAM

TRIBUTARY MERRIMACK RIVER — MASSACHUSETTS

SCALE: 1" = 50' — DATE: NOVEMBER, 1979

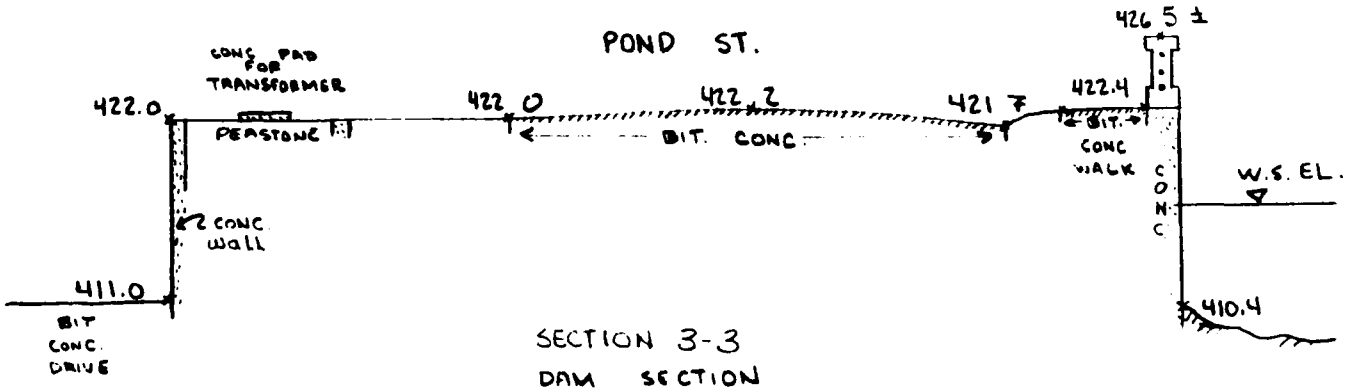
2



SECTION 1-1

SECTION THROUGH SPILLWAY

SCALE 1" = 10 FT



SECTION 3-3

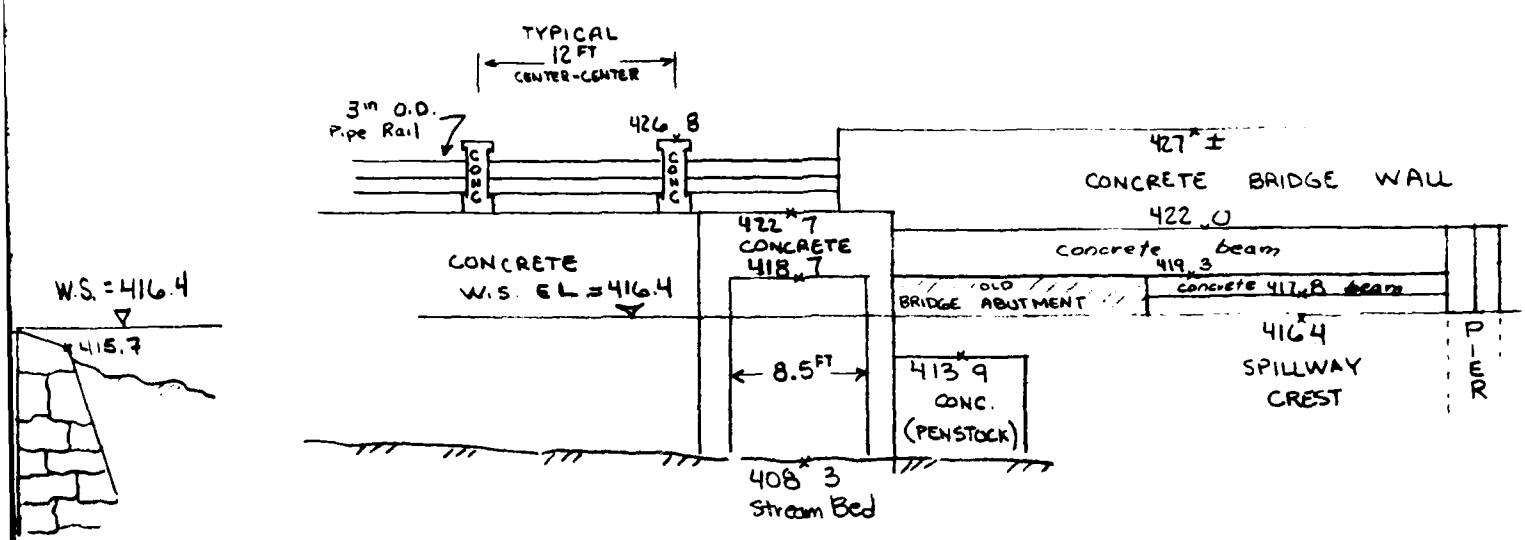
DAM SECTION

SCALE 1" = 10 FT

SCALE in feet

0 10 20

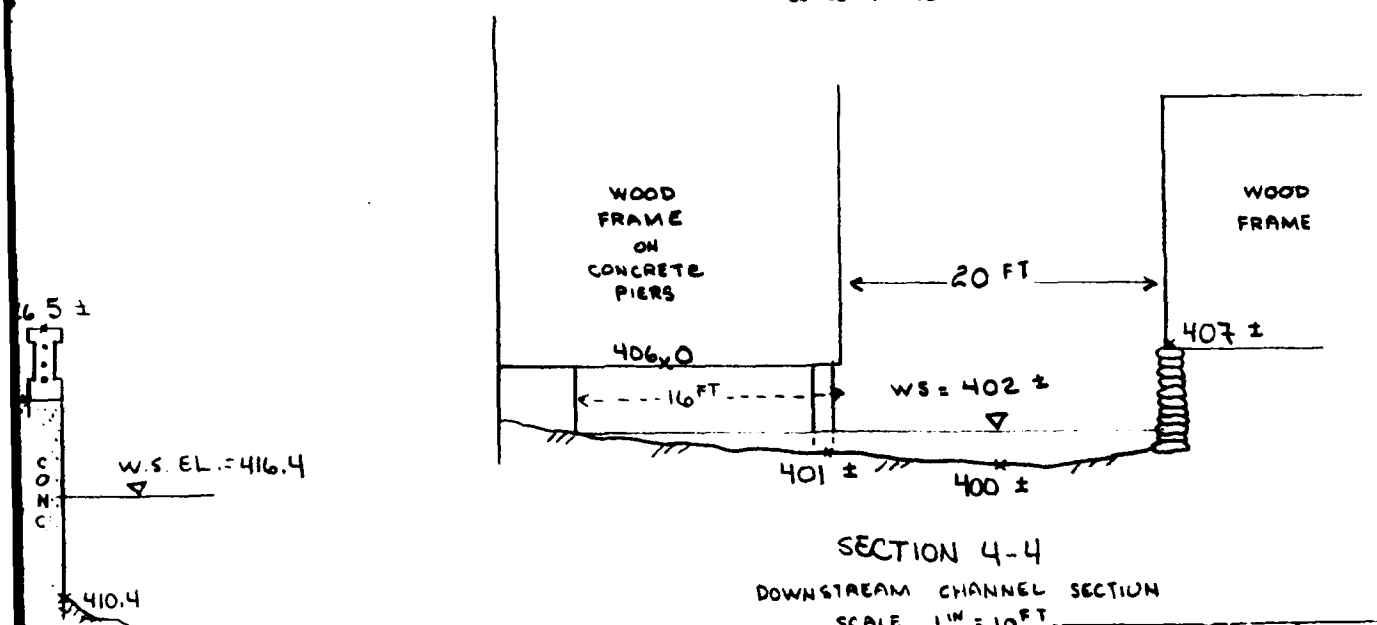
METCALF & EDDY, INC.



SECTION 2-2

PROFILE AT INTAKE STRUCTURE

SCALE 1" = 10'



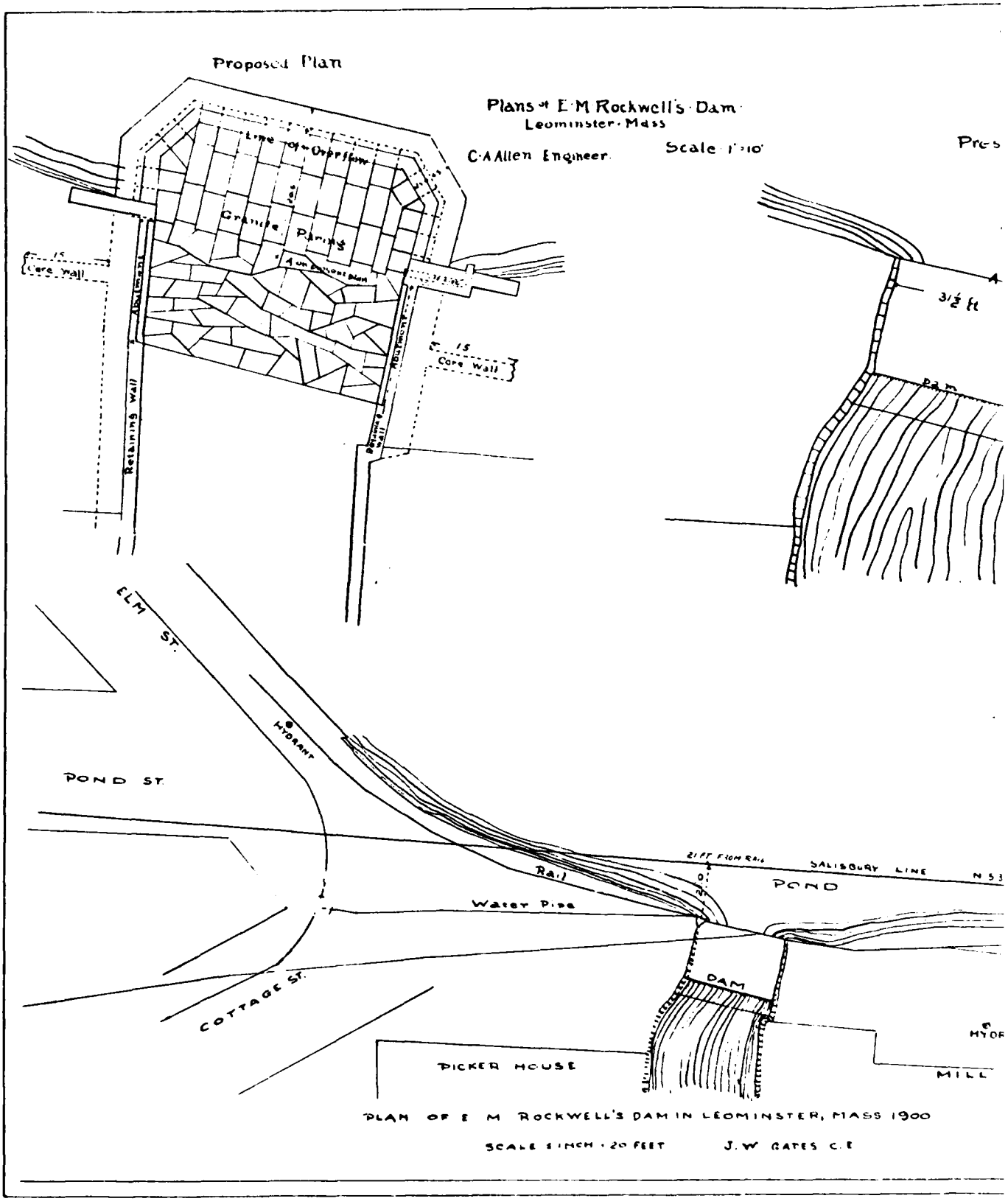
SECTION 4-4

DOWNSTREAM CHANNEL SECTION

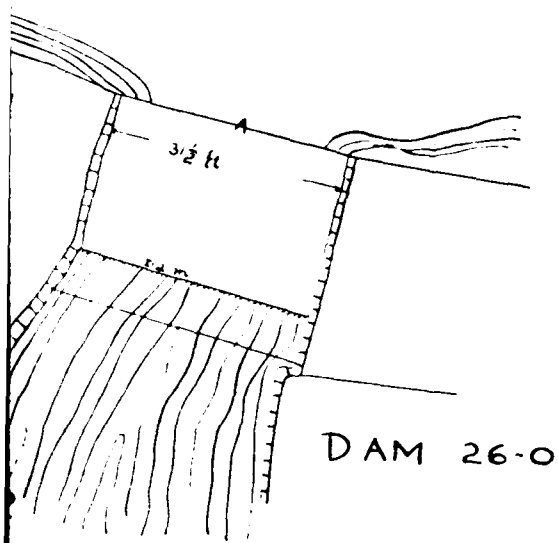
SCALE 1" = 10'

SCALE
in feet
10 20 30

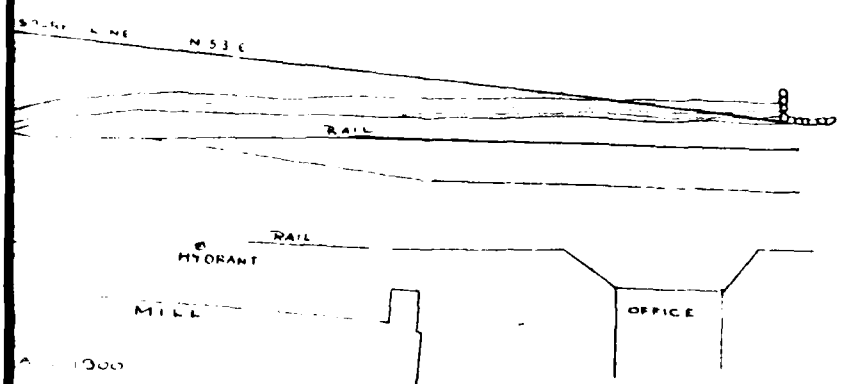
METCALF & EDDY, INC.	U.S. ARMY ENGINEER: NEW ENGLAND CORPS OF ENGINEERS
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
ROCKWELL POND DAM	
FIGURE 8-2 SECTIONS THROUGH DAM	
TRIBUTARY MERRIMACK RIVER	MASSACHUSETTS
SCALE: 1" = 10'	DATE: NOVEMBER, 1978


Proposed Plan
Plans of E M Rockwell's Dam
Leominster Mass
C A Allen Engineer
Scale 1"=10'
Line of Overflow
Granite Pavings
4 cm Bottom Plan
Core Wall
Abutment
Retaining Wall
Bracing Wall
3½ ft
Pond
ELM ST.
HYDRANT
POND ST.
Rail
21 FT FROM RAIL
SALISBURY LINE
POND
Water Pipe
COTTAGE ST.
DAM
PICKER HOUSE
MILL
PLAN OF E M ROCKWELL'S DAM IN LEOMINSTER, MASS 1900
SCALE 1 INCH = 20 FEET
J.W. GATES C.E.

Present Plan



DAM 26-08



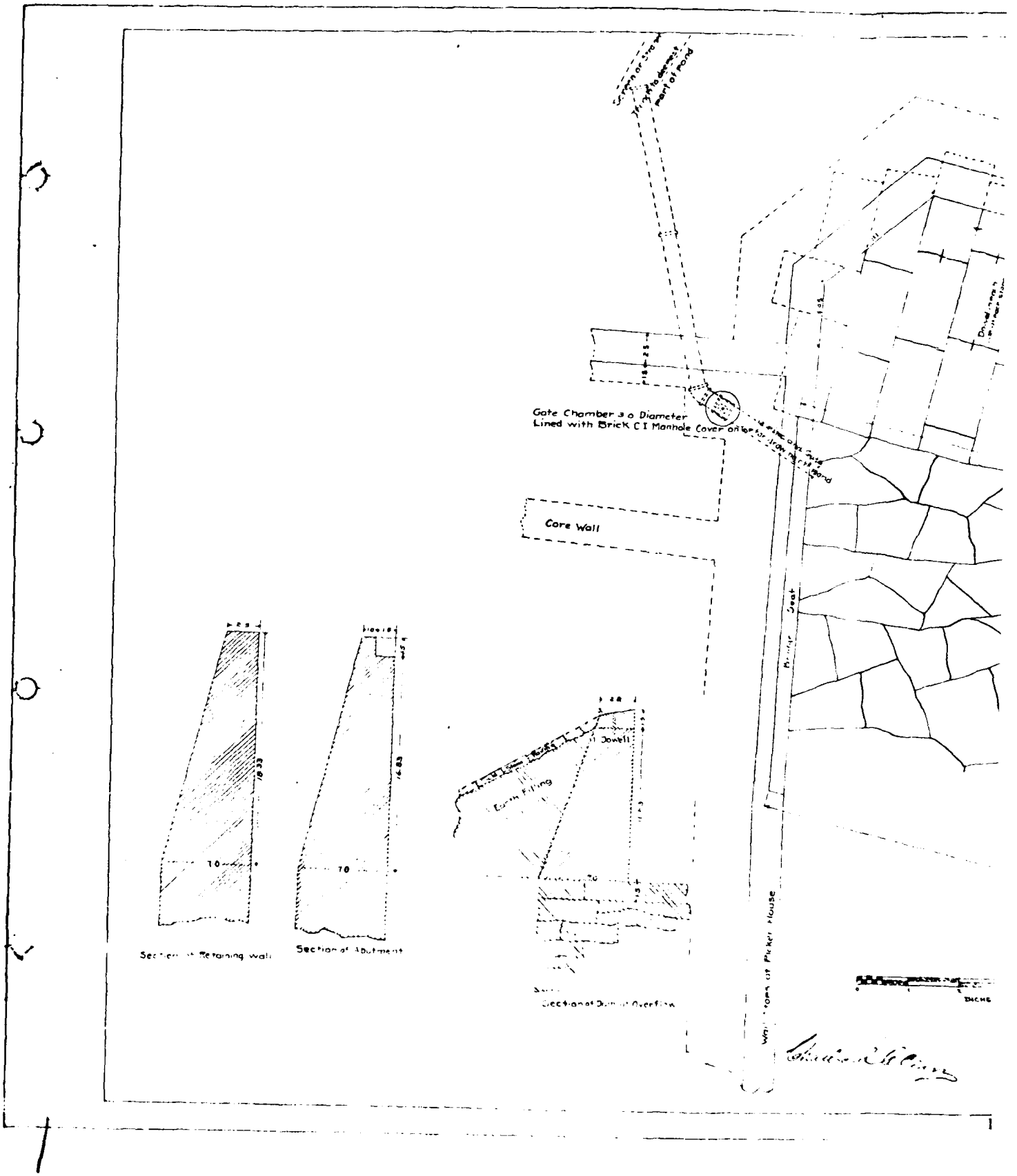
NOTE:
PLAN REDUCED FOR THIS REPORT

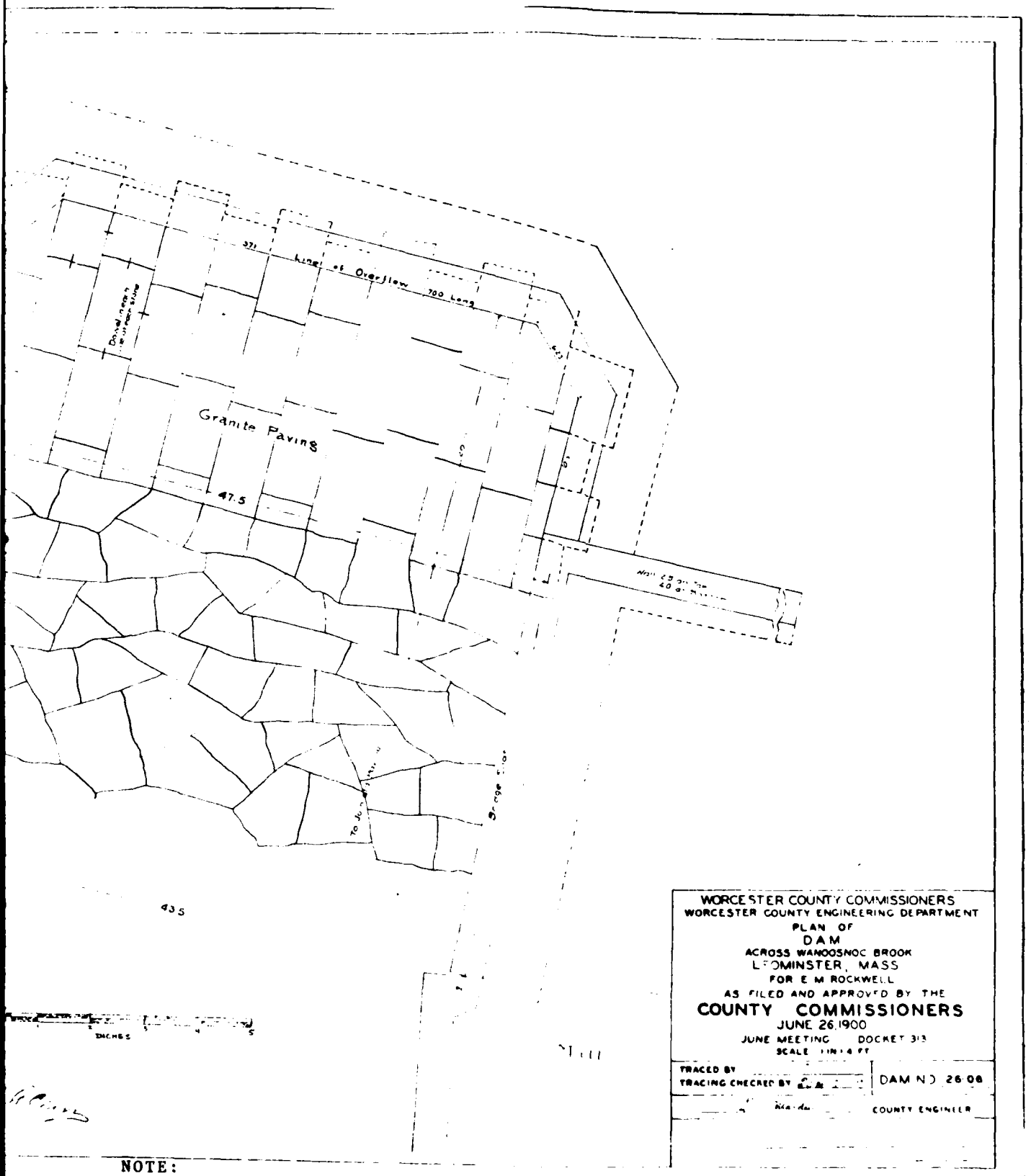
WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
PROPOSED NEW SPILLWAY
ON MONOOSNOC BROOK
LEOMINSTER MASS
FOR E.M. ROCKWELL
AS FILED AND APPROVED BY THE
COUNTY COMMISSIONERS
JUNE 26, 1900
JUNE MEETING DOCKET 313
SCALES AS NOTED

TRACED BY
TRACING CHECKED BY
DAM NO 26-08

COUNTY ENGINEER

ROCKWELL POND DAM FIGURE B-3


Gate Chamber 3.0 Diameter
Lined with Brick C I Manhole Cover on Iron
Core Wall
Earth Filling
Jowell
Section of Retaining Wall
Section of Abutment
Section of Drain at Overflow
Wall Section of Picket House



NOTE:

PLAN REDUCED FOR THIS REPORT

ROCKWELL POND DAM

FIGURE B-4

TOWN OR CITY Leominster DECREE NO. 313. PLAN NO. DAM NO. 26 - 08

LOCATION Below Kingman Dam - On Orchard St - Rockwell's Pond C. C. DOCKET NO. 69 Feb. 18

DESCRIPTION OF DAM

Type Granite Masonry Spillway - Hy Emb. El. 100'
Length 165'
Height 17'
Thickness top Spillway 6'0" - Highway = 30' ± all chg
" bottom " " 45' ± emb. 45' ±
Downstream Slope Part Rubble - part 1½ : 1.
Upstream " " " " "
Length of Spillway 31½ Ft. between Abts - 72' ± around crest El. 99.0 Depth = 50'
Size of Gates El. 83 20" Clean out pipe - 7x7 to mill
Location of Gates Man Hole near rollway
Flashboards used None.
Width Flashboards or Gates
Dam designed by Charles A. Allen, C.E. Worcester
" constructed by
Year constructed

GENERAL REMARKS

Owned by Rockwell Woolen Co.
See Vol 27 - P. 443 - Feb 18, 1900
Spec. " 29 - " 171 June 26 " for Reconstruction
Inspected Nov. 17, 1924 - No recent repairs
Small leak 6' below top of spillway.
Condition: Good

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream Monoosnoc Brook
" " any other Streams
Length of Watershed
Width " " } Traced by: L.C. Farra
} Checked by: L.O. Marde
Is Watershed Cultivated
Percent in Forests
Steepness of Slope
Kind of Soil Fitn. - Rocky
No. of acres in Watershed 11[illegible]5 +/-
" " " " Reservoir 50.
Length of Reservoir
Width " "
Max Flow Cu. Ft per Sec.
Head or Flashboards-Low Water
" " " -High "

GENERAL REMARKS

Rockwells Pond
Second Inspection Nov. 12. 1926 by
Inspected: April 27, 1933 - L.O. Marden
" : Aug. 1, 1936 - " + Mr. Ray
Blueprint : Oct. 10, 1938 - B.P. St. John
"
Inspected
" Oct. 9. 1943 - L.O. Marden
" Dec. 11, 1946 - E.C. Corcoran

B-5

ROCKWELL POND DAM

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.O.M. Date Nov.17,1924 Dam No. 26-08

Town Leominster Location Below Kingston dam.

Owner Rockwell Woolen Co. Use Power and washing.

Material and Type Highwat Embankment. granite masonery spillway.

Dam Designed by Constructed by Year

SPILLWAY LENGTH 72

El. top Abutment 100 El. Crest 95 El. Apron El. Streambed 93

Width top Abutment 30 Width top Crest 30 Width bottom Spillway 45

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition

5x6 penstock to mill.

EMBANKMENT LENGTH 100

El. Top 100 El. Natural Ground Width Top 30

Width of Bottom 45 Upstream Slope 1½:1 Downstream Slope 1½:1

Kind of Corewall Riprap

Material in Embankment rocky soil Foundation

Condition good -- cut off small bmish.

GATES Location

Size 7x7 Kind El. Flowline

Condition

WHEEL Kind Rodney Hunt. Size 30" Rated H.P.

Location Ave. Head 17

Evidence of Leaks in Structure small leak 6' below top of spillway.

Recent Repairs and Date

Topography of Country below Dam city

Nature of Buildings and Roads below Dam factory

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

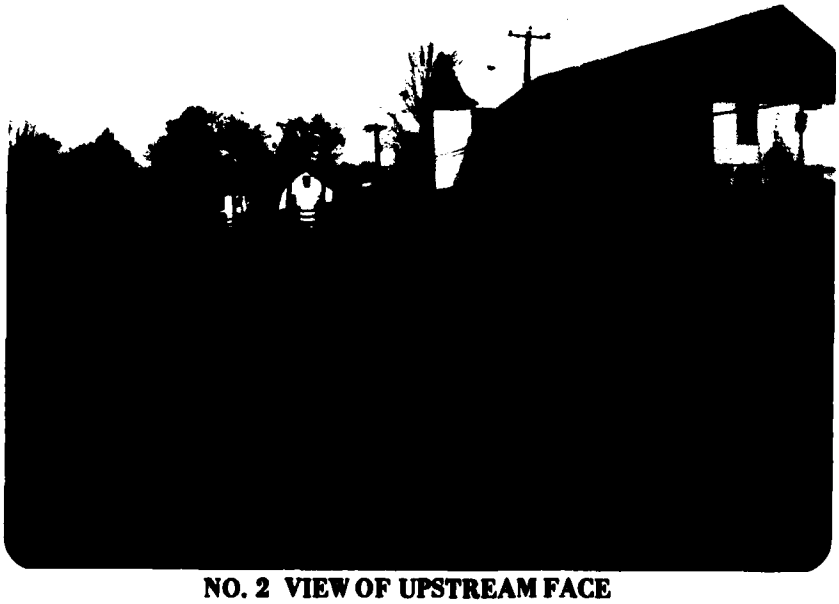
Estimated Storage Million Cubic Feet

APPENDIX C

PHOTOGRAPHS

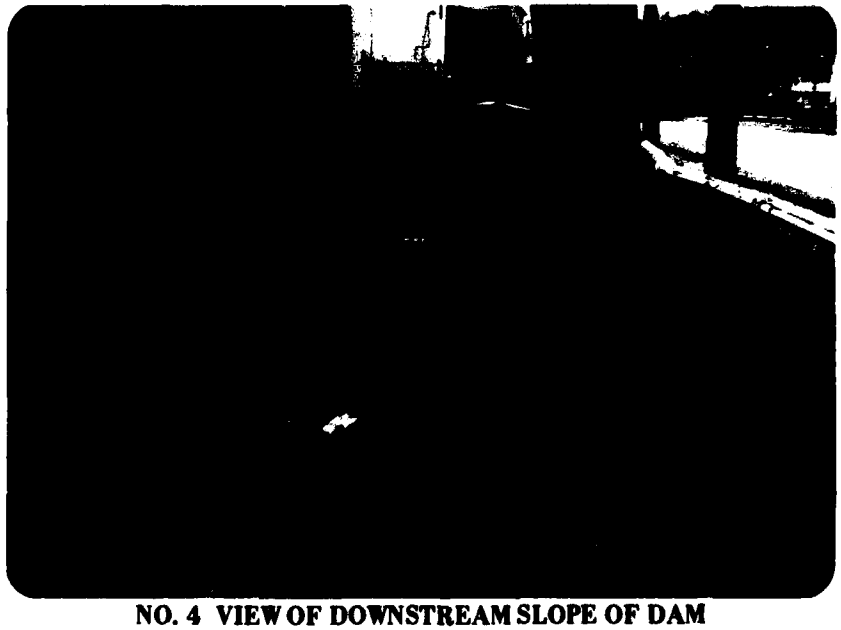
Note: For location and view of photographs, see Figure B-1

NO. 1 VIEW OF ROADWAY ALONG CREST OF DAM

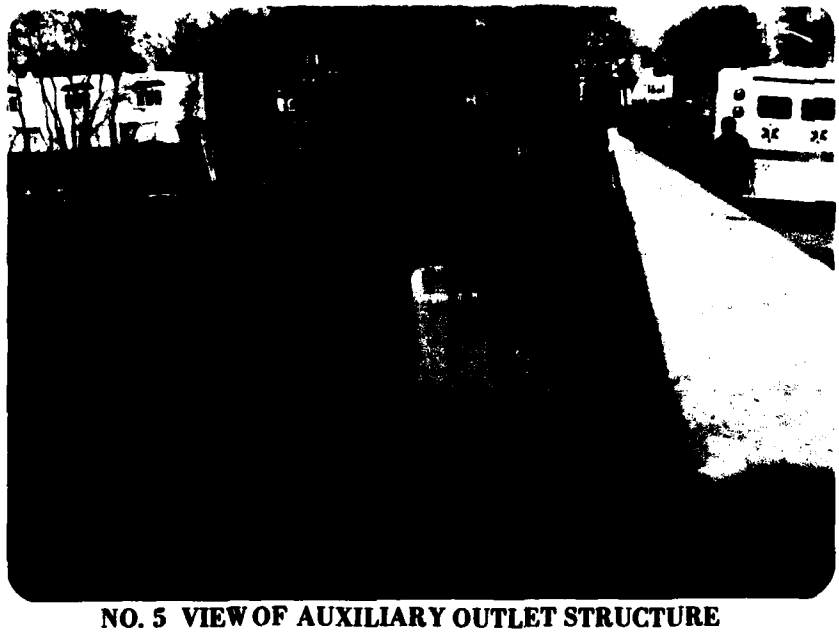


NO. 2 VIEW OF UPSTREAM FACE

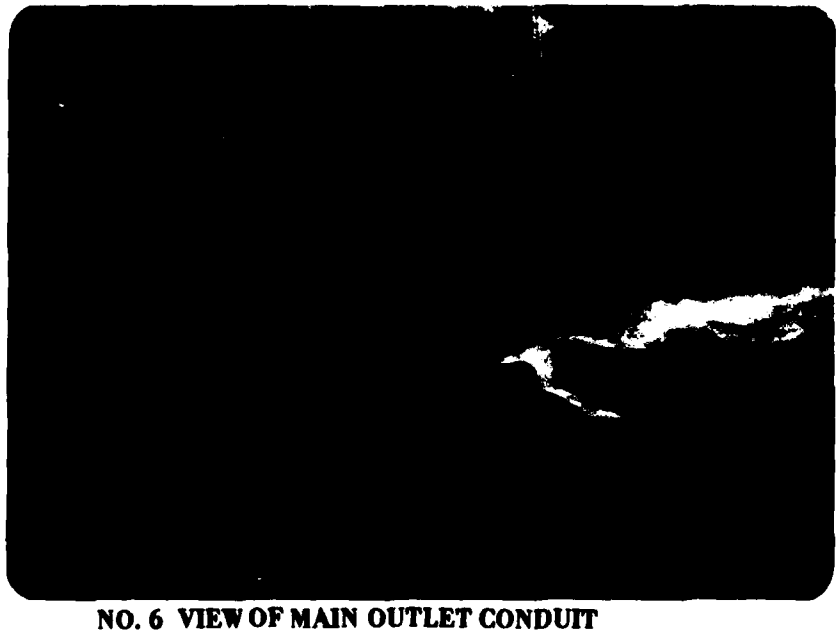
NO. 3 VIEW OF UPSTREAM FACE NEAR RIGHT ABUTMENT



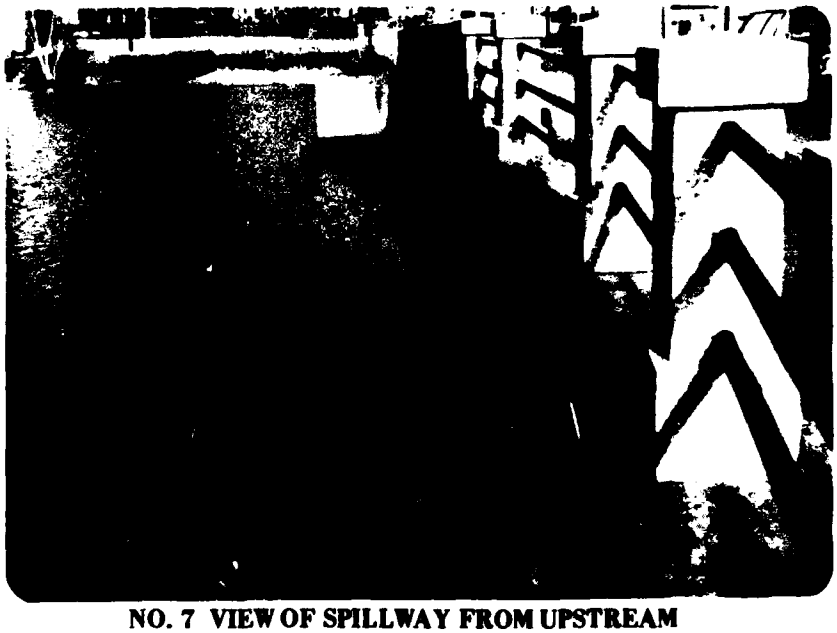
NO. 4 VIEW OF DOWNSTREAM SLOPE OF DAM



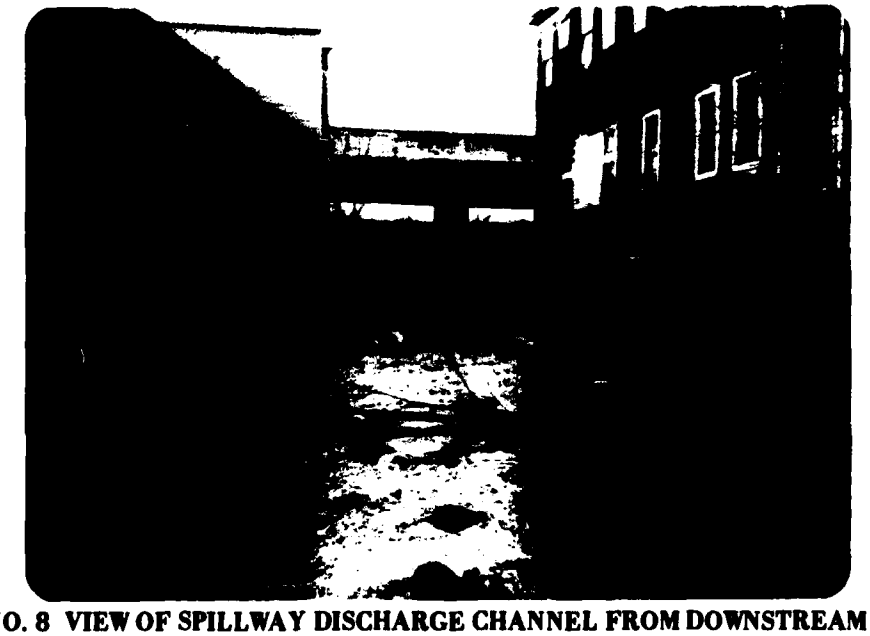
NO. 5 VIEW OF AUXILIARY OUTLET STRUCTURE



NO. 6 VIEW OF MAIN OUTLET CONDUIT



NO. 7 VIEW OF SPILLWAY FROM UPSTREAM



NO. 8 VIEW OF SPILLWAY DISCHARGE CHANNEL FROM DOWNSTREAM

NO. 9 VIEW OF MIDDLE OF SPILLWAY FROM DOWNSTREAM

NO. 10 VIEW OF SPILLWAY AND LEFT BRIDGE ABUTMENT

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

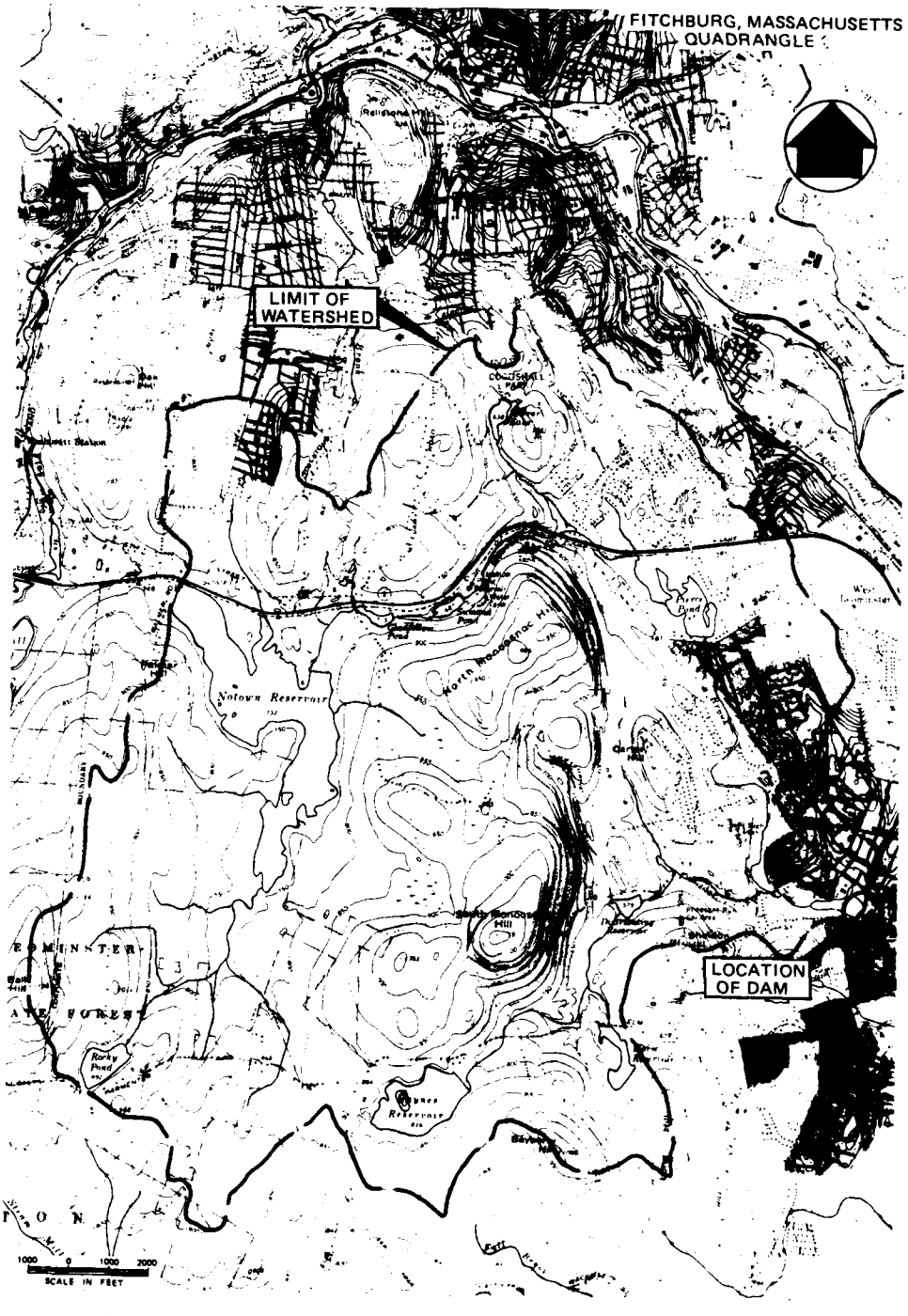


FIG. D-1 DRAINAGE AREA MAP – ROCKWELL POND DAM

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 1 of 5
Subject Worcester County, Mass Comptd. By LEB Date 12/17/79
Detail ROCKWELL DAM Ck'd. By MLL Date 1/21/80

(I) Test Flood, Storage & Storage Function

1- Available Data

U.S.C. of E. Report: "Hydrologic Analysis for Monoosnoc Brook Flood Control", dated October 1976, gives a Standard Project Flood peak discharge at Rockwell Pond of 4000 cfs This is a combination of 400 cfs from Notown Reservoir and 3600 cfs from the intervening area. The Notown Res. peak was 1410 cfs, occuring ± 5 hours after the peak from the intervening area. The S.P.F. was based on an 11.9 in. - 24 hr. rain, with an 8.7 inch peak 6 hour rain

2- Test Flood

Size: Small; Hazard: High; Test Flood: ½ PMF to PMF

Since the "Hazard" is the low end of "High" use ½ PMF

Test Flood Peak Inflow = $\frac{4000}{8.7}(9.5) = 4370$ cfs.

3- Storage

The nominal pond surface area is 10.7 acres or 0.017 mi²
Storage is taken as 10.7 acre ft per foot of rise

4- Storage Function

Based on: $Q_{out} = Q_{in}\left(1 - \frac{S}{R}\right)$ with S = Storage in Pond in terms of rain depth on drainage area, and R = rainfall in inches
Using D = rise in feet in pond due to storm = $12S\left(\frac{\text{Pond Area}}{\text{Drainage Area}}\right)$
and a drainage area 10.4 mi²;

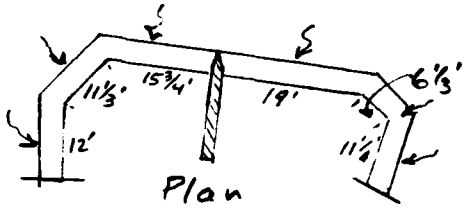
$$F_{TF} = Q_{out} = Q_{in} - \frac{Q_{in}\,S}{R} = 4370 - 460S = 4370 - 9D$$

Note: $F_{TF} = F_{½\,PMF}$

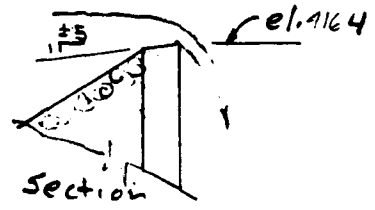
Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 2 of 5
Subject Worcester County, Mass. Comptd. By LEB Date 12/18/79
Detail ROCKWELL DAM Ck'd. By MCL Date 1/21/80

(II) Discharge Relations

1 - Spillway - as overflow structure



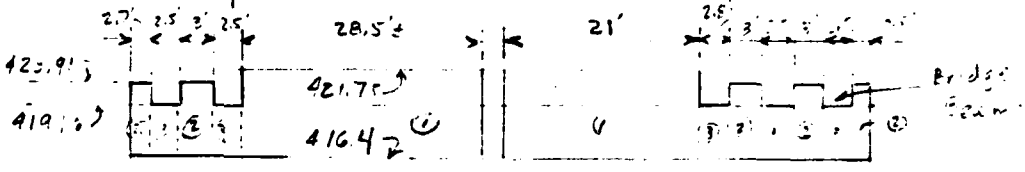
Total weir Length = 75⅔'
Say Weir Length = 75'
to allow for end contr.
$\therefore Q_1 = 262.5 H^{1.5}$



$C \simeq 3.5$
[Ref.: AWWA M13 "Spill. Des. Pract."]
Modified Sharp Crest

Pond El.	417	418	419	420	421	422
Q_1	150	580	1160	1870	2670	3570

2 - Spillway - as orifice



$Q = 0.6 A \sqrt{2gh}$ & h = head above ℄ opening

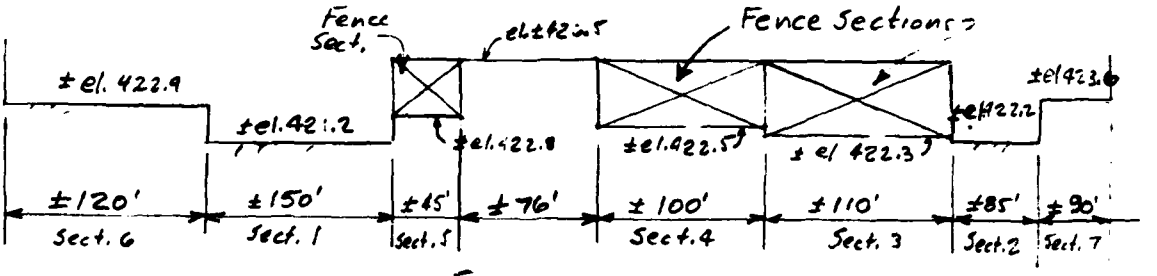
$Q_1' = 49.5(5.35)(0.6)\sqrt{2g}\,h_1 = 1275\sqrt{h_1}$; ℄₁ @ el. 419.1
$Q_2' = [2.7+3+3+3+0.5]4.51(0.6)\sqrt{2g}\,h_2 = 271.4\sqrt{h_2}$; ℄₂ @ el 418.7
$Q_3' = [2.5+2.5+2.8+2.5+2.5]2.76(0.6)\sqrt{2g}\,h_3 = 170.1\sqrt{h_3}$; ℄₃ @ el. 417.8

Pond El	420.1	421.1	422.1	423.1	424.1	425.1
Q_1'	1280	1800	2210	2550	2850	3120
Q_2'	320	420	500	570	630	690
Q_3'	260	310	350	390	430	460
ΣQ_2	1860	2530	3060	3510	3910	4270

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 3 of 5
Subject Worcester County, Mass. Compld. By LEE Date 12/18/79
Detail ROCKWELL DAM Ck'd. By MLL Date 1/21/80

(II) Discharge Relations - (Cont.)

3- Crest Flow



Assume $q = 2.55 H^{1.5}$ & fence sections are 70% "efficient."

Pond El.	421.5	422	423	424	425
$382.5 H_1^{1.5} = Q_1$ =	60	270	920	1790	2830
$216.8 H_2^{1.5} = Q_2$ =	—	—	160	520	1020
$196.4 H_3^{1.5} = Q_3$ =	—	—	110	440	870
$178.5 H_4^{1.5} = Q_4$ =	—	—	60	330	710
$80.3 H_5^{1.5} = Q_5$ =	—	—	10	110	260
$306.0 H_6^{1.5} = Q_6$ =	—	—	10	350	930
$229.5 H_7^{1.5} = Q_7$ =	—	—	—	60	380
ΣQ	60	270	1270	3600	7000

(III) Maximum Crest Discharge

Head at Low Pt. on Crest = 1.6 feet

$q = 2.55(1.6)^{1.5} = 5.16$ cfs/ft.

As critical flow : $y_c = 0.94'$, $V_c = 5.5$ fps

(IV) Main Outlet

± 35'-12"ϕ Pipe, Area: .785ft², el.ϕ 405.3, ave pond el. 415.8, $\bar{h} = 10.5'$

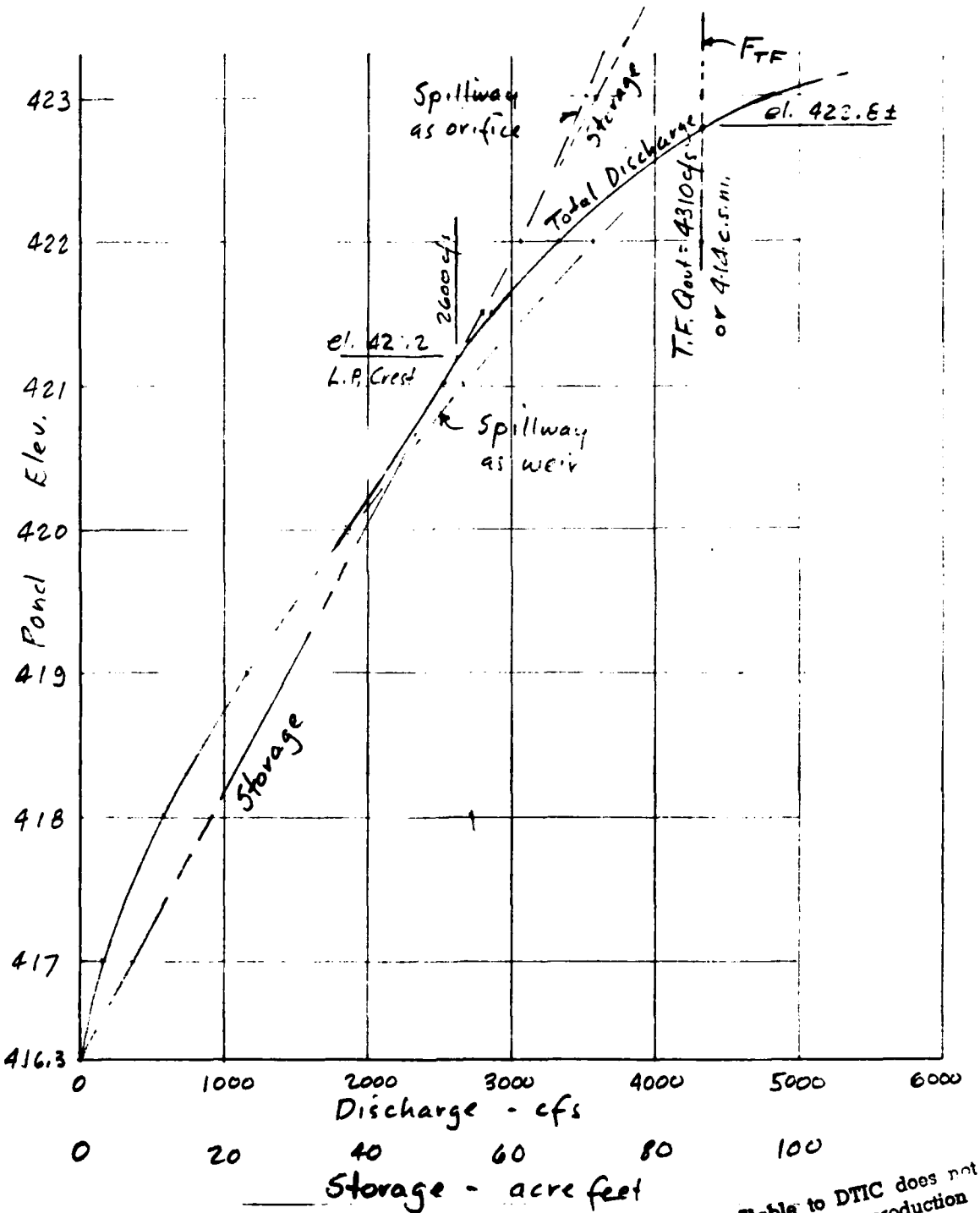
$\bar{h} \cong 1.6\frac{V^2}{2g} = 10.5$; $\bar{V} = 20.6$fps, $\bar{Q} = 16.2$cfs; Time for 1' lowering $= \frac{43560(10.7)}{16.2(3600)} = 8.0$ hrs

Project Nat. Review of Non Fed. Dams Acct No 6356 Page 4 of 5

Subject Worcester County Mass. Compld By LEE Date 12/18/79

Detail ROCKWELL DAM Ck'd By MLL Date 1/21/80

(V) Discharge, Storage & Storage Function vs Pond Elevation



(VI) Failure of Dam

Peak Failure Flow:

Pond Elevation - 421.2 (L.P. Crest)

Toe Elevation — 403.9 (orig. toe el. or 1900 flow)

Y_o = 17.3 ft.

Dam Length Subject to Breaching = 44 (11 to weir)

W_o = 40% ( ) = 23 ft sect. south. of river

$$Q_{P_1} = 1.68\, W_o\, (Y_o)^{1.5} = 1.68\,(23)\,(17.3)^{1.5} = 2800$$

± Half of ongoing flow continues ∴ add ½(2600) = 1300 cfs to above

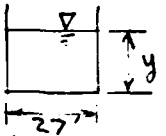
Storage Volume Released:

Storage Above Spillway 10.7 ( ) = 52.4 ac-ft

Storage Below Spillway 10.7 (12.4 ⅓) = 44.2 "

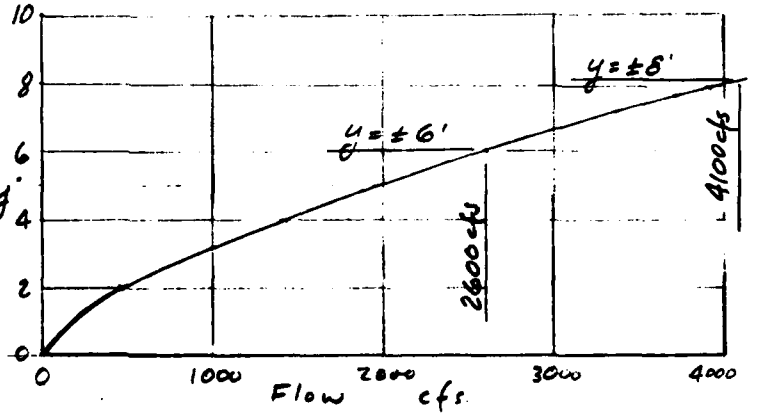
S = Total Storage = 96.6 "

Channel Hydraulics: Slope = $\frac{2.7}{230}$ = 0.0117, n ≃ 0.026



$A = 27y$, $P = 2y + 27$, $V = \frac{1.49}{.026} R^{2/3} S^{1/2} = 6.2 R^{2/3}$

y	A	$R^{2/3}$	V	Q	h_v	E
2	54	1.45	9.0	480	1.3	3.3
4	108	2.12	13.1	1420	2.7	6.7
6	162	2.58	16.0	2600	4.0	10.0
8	216	2.93	18.2	3930	5.1	13.1



Local Backwater should not hinder failure flow - flow is supor critical

With pond @ L.P. crest, failure of over half of weir causes minor rise in local dustr. water level.

No attenuation due to channel storage since impact area is immediately downstream

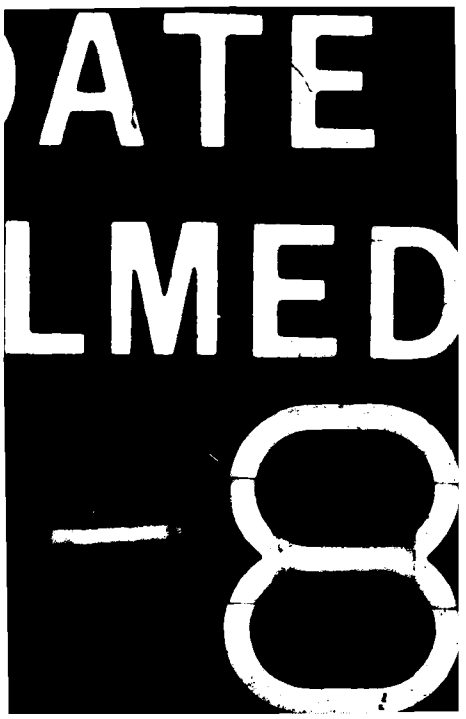
Time to Drain:

$$\frac{43560\,(96.6)}{3600\,(\frac{1}{2})\,(2800)} = 0.83 \text{ Hours, or } 50 \text{ Minutes}$$

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

ROCKWELL POND DAM


ATE
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-8

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DATE
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8-85